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The Journal of PARASITOLOGY

OFFICIAL ORGAN OF THE
AMERICAN SOCIETY OF PARASITOLOGISTS
FOUNDED BY HENRY BALDWIN WARD

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THE JOURNAL OF PARASITOLOGY

The Journal of Parasitology, published bi-monthly, is the official organ of the American Society of Parasitologists and as such it publishes the program of the annual scientific meeting, abstracts of the papers presented there, and minutes of the business meetings of the Society.

The Journal of Parasitology is a medium for the publication of the results of research in the field of animal parasitology. Manuscripts dealing with subjects in this field will be considered for publication, and accepted manuscripts will be published in order of receipt. A manuscript is accepted with the understanding that it is to be published exclusively in the Journal unless otherwise arranged in advance.

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Eloise B. Crane.

The Journal of Parasitology

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STEPPING STONES IN THE HISTORY OF THE AMERICAN SOCIETY OF PARASITOLOGISTS*

ELOISE B. CRAM

U. S. Department of Health, Education, and Welfare
Public Health Service
National Institutes of Health
National Institute of Allergy and Infectious Diseases**
Bethesda, Maryland

It is a great pleasure to be here today in this capacity; more than a pleasure, the fact that you bestowed upon me the Society's highest honor, its presidency, gives to me a sense of fruition after my many years in parasitology.

I had the privilege of being "on the inside," as they say, when events were occurring prior to the birth of A.S.P. I think without doubt that the Helminthological Society of Washington was the first stepping stone for this Society. It had been organized in 1910 and before the decade ended had added Baltimore members; it was natural that the initiative in forming a national society came from Helm. Soc., as it was called. I was secretary of the committee which surveyed the parasitologists of the country and, having had a favorable response, called a meeting at the time the AAAS met in Washington; the date was December 30, 1924. Details have been published (Chandler, 1946), and Dr. Cort, who was also on that committee and who was elected the first secretary and treasurer of the new Society, can fill in the story. I propose here to speak of certain events or certain facets of personality of some of the men who contributed directly or indirectly to those early years. I do this, first, because it is a pleasure to reminisce, and secondly, because many of you are too young to have known those persons. They are an index of that early period—and an interesting period it was. I hope you will agree with the latter.

Dr. Henry B. Ward was elected the first president of the new American Society of Parasitologists. At this time, he had had at least 25 years in which his primary activity was the teaching of zoology, with parasitology given prominence, first at the University of Michigan, then Nebraska where among other positions he was dean of the medical school for ten years, and finally at the University of Illinois where from 1909 through the rest of his life he developed and guided the Department of Zoology. Many of the men and women who have been our leading parasitologists were students of Ward's at either Nebraska or Illinois. I understand that he evidently foresaw from some distance a feature of present-day feminine

* Address of the retiring President of the American Society of Parasitologists, 31st Annual Meeting, Storrs, Connecticut, August 29, 1956.

** Laboratory of Tropical Diseases.

attire, in that one of his dicta was that women were *not* to wear their hats in his classes. Also, that a graduate student if particularly young in appearance would bring forth the comment: "Well, youth is one thing everyone gets over!"

For some time, I have been impressed with the parallel paths along which Dr. Ward and Dr. George H. F. Nuttall travelled. Nuttall was born in this country about three years before Ward. Both men after their early training in science taught for several years in this country, then went to Germany. Ward studied under various scientists but chiefly Rudolph Leuckart in Leipzig, and it was there that an interest in parasitology became predominent. Nuttall, after being in Berlin for several years, went to Cambridge, England and later was instrumental in the foundation and endowment there of the Molteno Institute of Research in Parasitology. Ward came back to this country and soon thereafter embarked on the teaching career which we have cited. Both Ward, with his Ph.D., and Nuttall, with his M.D. degrees, stimulated the subject of parasitology in medical circles of that day. It seems probable that Nuttall's establishing in England the Journal of Hygiene and later its supplement, "Parasitology," was an activating force for Ward who in 1914 started publication of the Journal of Parasitology. After our Society came into being in late 1924, all records of its meetings were published in Ward's Journal. Soon, however, the Society through the Council expressed its wish to publish its own journal. Dr. Hegner was one of the leaders. A committee consisting of Drs. Cort, Stoll, and Schwartz approached Dr. Ward on the basis that the Society did not wish to compete with Dr. Ward and would he not give up the Journal, in order that it might be the official organ of the Society. It took seven years to accomplish this objective. At one point, Dr. Ward labelled Dr. Schwartz "a pirate" but after steady growth of the Society to almost 600 members, Dr. Ward in 1932 transferred the Journal of Parasitology to the ASP. A provision was made that the front cover of the Journal would always carry the legend "Founded by Henry Baldwin Ward." Also, in 1932 the Society was incorporated; that year therefore had two big stepping stones for ASP.

Dr. Nuttall, by the way, attended the second annual meeting of ASP in 1926, giving an illustrated address on Piroplasms. He also made a short speech at the Society's luncheon and took part in the discussions of papers presented on the program. I feel therefore that directly or indirectly Dr. Nuttall was a significant factor in the background of ASP.

Dr. Charles W. Stiles, who succeeded Dr. Ward in the presidency, had a naturally zestful and forceful personality. He had had considerable European training and experience. After Wesleyan University in Connecticut, he studied at the Collège de France, the University of Berlin, and the University of Leipzig; he obtained his Ph.D. at this last institution. He also spent time at the Trieste Zoological Station and the Pasteur Institute. After his return to the United States he was appointed Zoologist with the Bureau of Animal Industry of the Department of Agriculture in 1891; later he went to Berlin for two years (1898–1900) as Scientific Attaché at a time when the problem of trichinosis was receiving much attention. In 1902, he entered the U. S. Public Health Service.

Dr. Stiles' years abroad, especially in Germany, had stamped him not only with a military bearing, which exhibited itself in his delight in wearing his uniform and all embellishments, including a sword, on all appropriate occasions, but they also

were evidenced in other characteristics. He came in for considerable "ribbing" and, being very good-natured, it seemed to please rather than displease him. An example is seen in the lines written by M. C. Hall:

"Professor Rudolph Leuckart's fame
Was known for miles and miles.
He tried to make a German out
Of Charley Wardell Stiles.
He taught him how to smoke a pipe
And how to drink his beer.
It's lucky that he didn't keep
Him there another year!"

Extremely cordial and helpful to others, he however had an active adversary in Dr. Franz Poche of Vienna. Dr. Stiles was Secretary of the International Commission on Zoological Nomenclature; Dr. Poche was on that Commission as Chairman of the Association of German-speaking Entomological Societies. Several articles, at least 6, and one of them 20 pages long, included Dr. Stiles' name in the title. Then in 1929, the American Society of Parasitologists was brought prominently into an article which Poche published in English, undoubtedly so that none of us could give the excuse that we did not read German. The title of this article is "Dr. Stiles' 'American referendum' on three propositions in Nomenclature." In this, Dr. Poche plainly inferred that Dr. Stiles had appointed committees which he knew would give reports to his liking and quoted the report of Dr. Cort, then secretary of ASP, for the Committee on Nomenclature, consisting of Drs. Hall and Schwartz. This Committee had been appointed by the president, Dr. Stiles. After a considerable list of what he considered erroneous statements made by this Committee, Dr. Poche gave his final thrust of sarcasm "And this was in Washington, the great center of American biological science!" Thus did our fame spread; at least in Dr. Poche's estimate that incident comprised a very slippery stepping stone in the Society's history. On the other hand, in 1928 and thus previous to the appearance of Dr. Poche's vigorous analysis and accusations, Dr. Stiles had published in the Zoologischer Anzeiger a brief article with a title which I am sure you will agree is of unique wording "Why I do not reply to Dr. Poche's attacks." This was done at the urging of various European colleagues. The essence of this note is contained in these sentences: "Polemics do not interest me, and as soon as I notice that a given paper passes from the spirit of calm and friendly cooperative discussion, even on differences of opinion, to one of personalities, I cease reading it and send it to the files. Dr. Poche's attacks on me are not of the slightest interest to me, I do not read them." There are those of us who doubt the accuracy of the last statement; we are convinced that his curiosity would not have allowed him to send them to the files unread!

Old-timers in what is now the large, spreading National Institutes of Health and which in Dr. Stiles' time was the small, compact Hygienic Laboratory all respond with pleased expressions to a reference to him and have one or more particular events which are starred in their memories, in which he participated. One of the highlights is a heated argument in which Dr. Stiles and Dr. George W. McCoy vied with each other. The objective: To secure, each for himself, the dangerous job of cleaning parrot cages when a study of psittacosis was under way. Means of transmission were unknown and the tragic toll of about a dozen cases, including

one death, during the early stages of the work emphasized the degree to which each of the two men felt responsible in assumption of the danger. Dr. Stiles maintained that he was the oldest officer there and thus had the *right* to risk his life in this wa Dr. McCoy maintained that he was Director of the Hygienic Laboratory and as such was *privileged* to shoulder the risk of contracting the disease. Dr. McCoy, as Director, of course had the final say.

A man who must not be forgotten as an important stepping stone in the events preceding and during the initial stage of our Society was Brayton H. Ransom. The Society was deprived of his participation after his untimely death in September, 1925. However, he was on that original committee which took the first steps to form the ASP and he was elected to the first Council to serve for 4 years. He had been closely associated with Dr. Ward and Dr. Stiles. He published his first two papers in 1900 and 1902 on bird cestodes while a graduate student in Dr. Ward's department at the University of Nebraska. After coming to Washington he was first in the Zoological Division of the Hygienic Laboratory, U. S. Public Health Service, then went to the comparable division in the Bureau of Animal Industry, whereas Stiles did just the reverse.

If I may be permitted to introduce a bit of personal history, I acknowledge most appreciatively that Dr. Ransom was responsible for my becoming a parasitologist, and thus for my standing here today. This of course is not listed among his many accomplishments in any biography. As to the modus operandi, I embarked on a career as bacteriologist the day after I obtained my B. S. degree, but during my first year in the Chicago stockyards Dr. Ransom made periodic visits in connection with his studies on *Ascaris* of swine and I was able to do a little laboratory work of use to him. The result was that when I made a change in position it was also a change in subject and place, and I came to work with Dr. Ransom in the Zoological Division in the U. S. Department of Agriculture in Washington. After Dr. Ransom's death, Dr. Ward paid me a great and certainly an undeserved compliment when, in the summer of 1926, he himself went off into the field and turned over to me the organization and editing of the September number of the Journal of Parasitology as a Ransom Memorial Number. Dr. Ward did not approve of everything I did—perhaps he expressed himself more volubly to others than to me. The parasitologists of the 20's were extremely courteous and generous to this feminine "upstart." However that may be, the memorial number did appear, with articles by twelve of Dr. Ransom's associates. In addition a Memorial Trust Fund was established by relatives, friends, and scientific colleagues in this and other countries—certainly the first international honor of this kind to be paid to a parasitologist.

By contrast to Ward and Stiles, Dr. Ransom was much quieter, almost reticent. In searching my memory for a small incident which portrayed both the personal and professional characteristics of Dr. Ransom, the one I like best had as its setting the elm-ringed elipse south of the White House. Several of us almost daily walked (no, we did not drive) from our laboratory at 12th and B Streets, now Independence Avenue, S.W. to the cafeteria of the Department of Interior at 18th and F Streets, N.W. As you who were contemporaries will remember, Dr. Ransom was always fastidious in his appearance—well-dressed is the term—and on this day he had on a new panama hat. As we passed under one of the elms, there came

from above an unmistakable token of bird life, deposited on Dr. Ransom's new hat. Without a word and very soberly (although we others were convulsed with mirth, although a sympathetic mirth), he removed the hat, placed in on a park bench, drew out of his pocket a little note book, tore out two blank pages and with one scooped up the specimen onto the other piece of paper, which he carefully folded and wrapped in his handkerchief, which was then returned to his pocket. He had studied bird cestodes at various times ever since his graduate days at Nebraska and he was not going to miss a chance to examine this specimen, which some might say had descended from Heaven. And what an aim it was!

One of our early presidents was Dr. Nathan A. Cobb. In his presidential address at the 1929 meeting of ASP, Dr. Cobb reported on his examination of about 250 zoological and biological textbooks published in the English language, and bolstered his opinion that textbook treatment of "nemas," as he preferred to term them instead of the longer "nematodes," had retrograded rather than advanced. He developed under the heading "J'accuse" eleven concise accusations showing not only inadequate but inaccurate treatment, citing misstatements and omissions of both parasitic and free-living forms. The address drew considerable attention, even the British Medical Journal reviewing it with commendatory comment.

Dr. Cobb was born in New England of a family of several generations of New Englanders; he had a facile imagination plus mechanical ingenuity, and when scientific training and wide experience were added, plus a well-developed sense of humor, the result was a delightful personality. He too went to Germany for his Ph.D. at Jena under the famous Haeckel, then to Naples Zoological Station, then to Australia for about 10 years. He did considerable work on parasites of livestock in New South Wales but even there, and afterwards in Hawaii and finally in the United States Department of Agriculture, his greatest interest centered in free-living and plant parasitic nemas. Many persons recall Dr. Cobb's crescent-shaped lens which he wore as a pince-nez on only one eye which needed aid for reading or other close work. Similarly he had a variety of delightful mannerisms which were uniquely his. All who heard his dissertation on "Holes," given at a Helminthological Society banquet, were treated to an example of histrionic ability and imaginative genius. Unfortunately no record was made but the following series of events is agreed upon. Dr. Cobb arrived at the specified hotel at the last moment by taxi and came into the hotel carrying a suitcase—some say up to four suitcases—under the weight of which he staggered in, refusing help from taxi driver, doorman or any of his fellow diners. When Cobb's turn came to contribute to the program, he cleared a big space on the table, put the suitcase on it. He then explained that he had a hobby of which few people knew, and so far as he knew no one else had this hobby. *He collected holes!* And because of his travels to many parts of the earth he had had opportunities to make a very varied collection. At this he opened the suitcase, spread it out and with great satisfaction and pride he proceeded to lift from it (clearly seen by the imaginative) one after another of his "holes," as he described each one. Highly prized was a *fence-post hole* from Australia. Since there were so few fences in Australia the finding of a fence-post hole was a great piece of good luck. Choicest of all was his *fossil* hole, the oldest one extant.

It is said that Dr. Cobb described about 1000 new species of animal and plant parasites. I cannot vouch for that figure but I do know that he announced in May, 1920 that he was about to publish a paper dealing with the morphology of 120 new *genera* of free-living nemas. It was inevitable that in the magnitude of such investigations, plus his other highly diversified activities, he should be guilty occasionally of forgetfulness and commit errors, especially in nomenclature. These instances made Dr. Albert Hassall's bald head grow even balder, as he classified the nemas in his files in the Bureau of Animal Industry (BAI). Dr. Cobb is chided gently about this in a place-card verse written by M. C. Hall in 1922, as follows:

"Nematode, nematode,
Wilt thou be mine?
You shall not live in horses,
Or cattle, or swine,
But feed upon roses
And lilies so white,
And have a new Latin name
Every third night."

This trait is much less delicately referred to by Dr. Cobb himself, in a demonstration both of his delightful sense of humor and of his skill with verse, read to Dr. Hassall at a testimonial dinner given to the latter by the Helminthological Society in 1922 after Dr. Hassall had been awarded the Steel Memorial Medal. Although it is rather long, it seems impossible to delete any of the five stanzas of Dr. Cobb's poem:

"The Recording Angel"
(Postprandial)

When I meet the recording angel
Of the mighty B.A.I.
My sins rise up before me
And smite me hip and thigh.
For I know there's no escaping
His well known, eagle eye.
He spots my every error
And intends to till I die.
And he writes them in his Files,
Inscribes them in his Files.

If I have two MS species
Of the same generic form,
And because I'm absent minded
Or my brain is in a storm,
I name them in terms identic
For my old friend Dr. Dorm,
It's, "What the Hell you doing?"—
Or something just as "warm."
So this escapes his Files,
Thanks be, escapes his Files.

But if I rediscover
A form from the misty past
And mistakenly rename it,
I never hear the last
Of how I've bunged the works up
With the "wrenches" I have cast,
"At your abysmal ignorance
The whole world stands aghast."
For he'll have it in his Files,
He'll have it in his Files.

If I named a species *"minor"*
In the long, long, long ago,
And after time's gone flying
What seems an age or so,—
I apply it to a brother species,
I quaff the bitterest woe!
It's "Cobb, your case is hopeless,
I'd make my will and go!"
He'll have it in his Files,
He'll have it in his Files.

And when I land in Tophet
I shall hear it relayed down
From the land I left behind me,
As I sizzle and I brown;—
"There's one thing I'd forgotten,
That genus from beyond the town,—
The name you went and gave it
Is an *adjective*, not a noun."
It's up there in his Files,
It's up there in his Files.

In addition to admitting his own faults, Cobb has here delightfully characterized the colorful language used by Dr. Hassall. The latter was not a joiner; as far as I know he was never an ASP member. However, his work has contributed immeasurably to research in parasitology and will continue to do so. Who has not leaned heavily on first the Stiles and Hassall and subsequently on the Hassall and Potter Index Catalogues, now being continued by Miss Mildred Doss and coworkers? Dr. Hassall was extremely friendly—the sparkle in his eye betrayed the stern words he might be speaking but certainly he excelled in the uninhibited language he used when a person, or that person's acts, met with his disapproval. Dr. Schwartz introduced Dr. Hassall at the aforesaid dinner with the following, and I am sure Dr. Hassall enjoyed it at least as much as everyone else:

What if yon blokey struts and puffs and fumes in his small castle?
"Big sap! Poor fish!" said Dr. Albert Hassall.
Cow-tow to power and glory, be anybody's vassal?
"Not on your life, not I," quoth Dr. Albert Hassall.
"What G-damn difference does it make if you wear a golden tassel?
It's brains that count, you fathead," spake Dr. Albert Hassall.

I think there is no doubt that the instigator of the say-it-in-verse era of festive dinners for various occasions in Washington was Dr. Maurice C. Hall, who was active in the formation of ASP also and was active in its meetings for more than a decade. He was president of the Society in 1932. Last December, Dr. Huff in his address to us on the occasion comparable to this one spoke of the desirability of parasitologists expressing themselves in poetic form more often, and he made reference to Dr. Hall as one who had done so. A 74-page booklet entitled "An Epic of the Tropics," illustrated with woodcuts by his daughter Marion, is a unique record of his trip with a group of parasitologists to Nicaragua. He expressed himself in verse with an ease and fluency greater than most persons do in prose. For the banquet to Dr. Hassall (1922) here cited, Dr. Hall wrote 27 poems, each at least a full page, some 2 pages long. Dr. Schwartz and Dr. E. A. Chapin collaborated with him on several occasions in producing ambitious programs, some of the gems set to music à la Gilbert and Sullivan. In a few instances, the verses

were published—in 1921, for instance, by the Journal of the American Veterinary Medical Association (July, pages 530–532). That Journal was a leader in recording Hall's verse, as he himself was a leader in the field of veterinary medicine for many years. In 1916 (April), the Journal had published his "Poetic Introductions at the Annual Banquet of the Veterinary Medical Association of George Washington University." Also, about that time some of his early verses on parasites, in a humorous vein, appeared in the Medical Pickwick, well known as it itself avowed as "A monthly magazine of Wit and Wisdom by and for Medical Men;" a letter from the editor, which reached Dr. Hall while he was in the Army in the first World War, deplored not having had recent contributions from him. Later (1923), there appeared in that magazine a more formal poem on "The Adventures of Science" in which he compared well-known historical explorations with those of the research scientist. Later, verses appeared in the Medical Mentor; in a letter in 1932, the editor of that magazine, in expressing great regret at some editorial changes made in earlier published verse of Dr. Hall's—which had made the latter "sad" when they appeared—asked him for more verses, to prove that all was forgiven if not forgotten.

The wide sweep of Dr. Hall's interests was apparent to anyone who knew him. You who were his friends will remember what a good conversationalist he was. He must have been a wide reader and student during his youth, in spite of the outdoor activities in his well-loved Colorado. Literature, music, history he knew well, Greek and Latin were familiar to him as well as some modern languages. He occasionally took delight in translating German poems into comparable English. He disliked the reactionary or ultraconservative; took pleasure in an independent, liberal stand, expressed in a provocative way which he hoped would stimulate a response. This and his interest in people are well shown in some lines he wrote while on one of his trips:

"Pickaninny dancing on a railroad tie,
Shouting and a-clapping as the train slides by.
Seated in the smoker, four men in a row
See a dancing darky kid past the window go,
Four dumb human animals who never smile or speak,
As far from one another as the ocean from Pike's Peak."

Hall published a considerable number of articles on non-parasitological subjects; ideas of a more capable government, for example, engrossed him. An avowed agnostic, he had a high standard of ethics representing a responsibility of each person to the whole human race. He knew the Bible well. In a paper addressed to the American Veterinary Medical Association while he was its president, he compared modern codes of ethics with the Apostles' Creed, the Golden Rule, the Sermon on the Mount, and other Biblical ethical pronouncements. The codes of modern times he found too heavily weighted with negative concepts, the "Verboten" dominating them too heavily, rather than their expressing positive, creative standards. In the struggle with the anti-vivisection movement, Dr. Hall took an active part, both in speaking and writing, trying to popularize the positive gains achieved by animal experimentation. The fact that he had discovered an anthelmintic that would rid dogs of their hookworms provided ammunition more forceful than claims of human benefits which came from the same experiments.

An amusing incident occurred at one of the Congressional hearings when an anti-vivisectionist in her zeal exclaimed to the Congressional Committee, pointing to Maurice Hall, "You'd know he'd torture animals! Look at his hard cruel face." Even to strangers, the remark was obviously incongruous; you can imagine the amusement it brought to others who knew him as a warm-hearted, always ready-to-help person—the experimenter who repeatedly spoke to an uncooperative horse or dog "Now, honey, don't do that!"

Review of Presidential Addresses

These, then, are a few of the men who helped launch our Society, and whom a great many of you did not know personally. Time does not allow our reminiscing about others. Let us look over the fields covered by our retiring presidents. I agree with the late Dr. L. O. Howard who stated when he was retiring president of the AAAS that it is "not amiss to deliver a presidential address on the subject of presidential addresses."

The addresses delivered at the annual meeting by the thirty preceding outgoing presidents* of this Society (all of whom, by the way, I have known personally) have followed two general lines. They may be divided as dealing with (a) a special interest or activity of that particular president or (b) with the needs, trends and accomplishments of parasitology.

At this point, I wish to acknowledge my indebtedness to former President Philip. After his retiring address and after my being designated president-elect at the same meeting, Dr. Philip gave me a typewritten list of all the previous presidents, the year each served and the title of the retiring address. I have a suspicion that this list which he prepared was to him a safety factor and that he thought if need be, he might do as Dr. L. O. Howard did. However, as you know, Dr. Philip sprang upon a startled parasitological world the announcement that helminth-borne salmon poisoning of dogs is a rickettsial disease. His experimental demonstration cleared up the long mystery of this disease, highly fatal to dogs which became infected—or should one say "infested" in this case—with the trematode *Nanophyetus salmincola.* The completion of this work was so perfectly timed that Dr. Philip's "Something new under the 'parasitological' sun" probably stands alone as an ASP presidential address of great immediacy. The close timing was evidenced, I happen to know, by the fact that when Dr. Philip came east from Hamilton, Montana for the ASP meeting, he brought with him final contributions from his experimentally fed dogs, in which the presence of eggs of the trematode provided the last step of the cycle. Isn't it fortunate that the annual meeting was in November of that year, *not* in August?

Another address in the category of a special interest of the speaker was a plea made by Dr. Stiles for better knowledge of the rules and principles of nomenclature. He urged that formal instruction be included in the training of a zoologist just as grammar would be in a school curriculum. Needed indices to the opinions of the Commission were published by Dr. Harley J. Van Cleave, and as retiring president, his address to the Society was a comprehensive analysis of many

* The full name of deceased presidents is given the first or principal time that person is mentioned. For living presidents, only the last name is given; they are well-known to members of the Society and a Membership List is easily available.

of the complications which had occurred in taxonomy and of the constructive accomplishments which had marked the field of systematic research, especially as regards his own favorites, the Acanthocephala. Dr. Cobb's forceful "J'accuse" as regards nematology has already been described. Ascariasis and its epidemiology, including his own findings, were dealt with by Dr. Cort. Trematodes have received attention; digenetic forms, their life history in relation to taxonomy by Dr. La Rue, and the many species occurring in American ruminants by Dr. Price, who covered the very complicated life histories of these parasites and known control measures. An analysis of life histories, from simple to complex, was made by Dr. Stunkard, with examples from ecto- and endo-parasites in various systematic groups and the significance as regards control of the parasite. Three addresses came from authorities in protozoology: Forms found in the human mouth by Dr. Charles A. Kofoid; the status of amebiasis by Dr. Charles F. Craig, and a comprehensive discussion of microtechniques as of importance in studies of morphology and significant as to identification of Protozoa by Dr. Wenrich.

Another address covering a wide range of parasites reviewed the problem and accomplishments in livestock parasitology, by Dr. Schwartz; the successful campaign against bovine piroplasmosis or "tick fever" was, undoubtedly, the greatest and held the most sensational elements of bitter opposition of any control campaign, but there are many others still incompletely solved.

Medical and veterinary entomology were discussed by Dr. Bishopp, and the disease relationship of chigger mites by Dr. Ewing.

The address on susceptibility and resistance in helminthic infestations by Dr. Chandler in 1931 was followed during the intervening 25 years by four addresses bearing on aspects of that subject: Some cellular bases for immune reactions by Dr. Taliaferro (1933); some of the factors responsible for host parasite specificity by Dr. Robert Hegner (1936); dietary, genetic and age factors involved in the development by the host of natural resistance, by Dr. Ackert (1941); and a look in reverse to that usually taken, namely, "How parasites tolerate their hosts" by Dr. Becker (1953) who advanced challenging hypotheses as to substances and processes involved.

Biography has formed the theme of only one of our presidential addresses. Dr. Cameron gave us a graphic account of the parts of Sir William Osler's life which had a bearing on parasitology. This was supported by numerous notes made by Osler himself, especially from his early experiences. As to his later influence, indirectly, he was responsible for the initial persuasion of John D. Rockefeller, Sr. and his son to finance medical research, this leading to establishment of the Rockefeller Institute. As this is described by Dr. Cameron, it reminds me vividly of another of those miracles of coincidence which provided the impetus which spurred John D. Rockefeller, Sr. to give an initial million dollars to start the hookworm eradication program. This was the result of a chance conversation of Dr. Charles W. Stiles with a fellow passenger on the train, that person being Thomas Nelson Page, who later told Mr. Rockefeller about it. (As told in "The United States Public Health Service 1798–1950" by Dr. Ralph Chester Williams, 1951, p. 143.) It makes one wonder what might have transpired if those "four dumb human animals" to whom Dr. Hall referred had got into conversation instead of being self-absorbed in complete silence in the train smoker!

Of our former presidents, Dr. Cameron was not alone of course in his interest in biography. Outstanding examples are Dr. Ward's biographical sketch of Leidy and Dr. Hall's of Theobald Smith and of Cooper Curtice. Dr. Van Cleave not only wrote about John Sterling Kingsley but has given us a series of biographies accompanied by reproductions of a large number of portraits of famous zoologists.

To return to Dr. Cameron, shall I tell you of my first meeting with him? I went to see him in his Edinburgh laboratory in the summer of 1930 and arrived right at tea time. *And* the tea was boiling vigorously in an open container above the burner. Imagine my shock—I who during all my early years had stood silently at a discreet distance, watching my British-born grandfather stand solemnly with his watch in hand while tea "steeped" in a preheated earthenware tea pot—only the water having been brought to a boiling point over the flame. Somehow, Dr. Cameron's boiling tea has always been symbolic—I don't quite know how—of the man himself; he gets things done, seemingly always with his ebullient good nature —and by the way, I find Webster defines ebullient as "boiling up," and it is good tea, whatever it is he does. How very much we owe to him and to his wife, Mrs. Stella Cameron, herself an outstanding zoologist and the possessor also of a rare form of ebullience.

To turn now from that category of presidential addresses which dealt with a particularity of parasitology, either as to parasite or host or the special aspect considered, let us look at those with wider discussions of the subject. Dr. Ward started this by considering the needs and opportunities of parasitology as seen in that first year of life of ASP. He reviewed the achievements of American parasitologists, including Leidy, MacCallum, Walter Reed, and Ricketts. Among the needs and opportunities for research, it is interesting that he listed first the pinworm, *Oxyuris vermicularis* as it was then called, and secondly, *Ascaris lumbricoides;* although we know considerably more about them now, these nematodes are too often with us in uncontrollable familial situations.

How interesting it would be if we could have the estimate of those pioneers on the progress made in the field in the intervening 31 years! In later addresses, parasitologist and parasitology have been repeatedly scrutinized. We have referred to Dr. Chandler's 1931 address. He was acting-president at that time; the Society's president, Dr. Riley was in China. Later, Dr. Chandler was president and early in 1946 gave his retiring address; he is the only person to give two addresses before the Society. In this second one, at the end of the war, he described the important parasitological problems and the response that had been made to this need, declaring that "Parasitology in America has come of age." Speaking less seriously, in defining the ingredients and the standards necessary to "The Making of a Parasitologist," he made the surprising comparison of a parasitologist with the rare and lovely orchid, but with an important qualification. If you have forgotten why the comparison or if you are too young to have heard the address and have not read it, pull out that June, 1946 number of the JP and make its acquaintance. We did not get any such bouquets from Dr. Faust, but from his long experience in 1948, he offered much advice as to the training, methods, and attitudes needed for a medical parasitologist, and he gave us a high set of standards as a goal toward which to work.

The international importance of tropical disease has been forcefully expressed

by several of our presidents and for those of us who are stay-at-homes, the significance of laboratory research is heightened. Dr. Richard P. Strong was the first who had had wide experience internationally; he was in the Philippines for 13 years, Manchuria for a year and during the first World War had had trench fever in France and typhus in Serbia. As first Professor of Tropical Medicine at Harvard University, he carried out a great many expeditions to Africa and to South and Central America. In 1927, with his address as retiring president of ASP, he showed a large collection of lantern slides dealing with scientific and non-scientific observations made in equatorial Africa during 1926–1927. The address was not published as such but the data are part of a 2-volume record of the expedition. Dr. Strong had tremendous energy and organizing ability, combined with a great breadth of interest. It is said that after he was 65 years of age, he still asserted his ambition to go back to the bush of Africa and shoot a lion with bow and arrow.

"The role of the parasitologist in World War II" came to the members of ASP in published form as Dr. Meleney's address which he had expected to deliver in person at a meeting (the 18th) of the Society scheduled for late December of 1942; he anticipated the problems and urged upon the members the various ways they could be of service in their specialty. Not only was the meeting not held that year but was again postponed in 1943, with the result that the program for that meeting was abandoned, except for the publication of the abstracts prior to the first planned date of meeting and the publication of Dr. Meleney's paper soon thereafter. Dr. Meleney has the distinction of being the only president to serve two terms.

The postwar situation and the significance of the great changes which had taken place or were in the foreseeable future, as regards tropical diseases, were dealt with by Dr. Wright in his retiring address in 1950: A well documented analysis of serious economic loss from parasitic disease in various parts of the world, the effect on food supply, the specific problems and the research methods aiming at ultimate control.

There is one presidential address which also would be classed in the international field of tropical medicine which has a title that undeniably has done more in 3 words to catch the imagination than would paragraphs of description. "This Wormy World" not only has been greatly cited in scientific and semipopular publications (I am sure the demands for reprints must have been great) but also for some time one of the biggest commercial drug companies has headed some of its advertisements with this title, given properly with quotation marks. Dr. Stoll, its originator, got into the international field very early in his parasitological career, having worked in Puerto Rico, China, and Panama during the 20's. He has since then had frequent experience with the parasitological situation in other countries, notably in the Pacific Islands during World War II.

Our conception of the field of parasitology and the trends which we should recognize and perhaps control seem to me to be well considered from three different points of view.

In answering the question "Is parasitology a science?", Dr. Hall probed into what is and what is not important in the world of science and analyzed the place our specialty holds. A little later—both of these were in the 30's—in a light vein

Dr. Tyzzer described the low social standing of an occupation dealing with *worms,* which even medical men refused to take seriously; the tremendous possibilities as to methods and objectives were pointed out in what today seems quite a prophetic bit of insight. Dr. Tyzzer's objection to the frequent talk of science as a tree with its many branches, and his preference for a conception of science in general as a 3-dimensional web or reticulum with free anastomoses carry greater weight in this day, more than 20 years later, when a parasitological problem may engage biochemists, pathologists, clinicians, serologists, sanitary engineers, and so forth. And so it was timely that in the last presidential address, Dr. Huff emphasized that the past laid the groundwork; the present challenge is that the workers in our field should discover the *principles* of parasitism. It is clearly evident, from the pressures we feel from many directions, that parasitologists must maintain and develop the status of parasitology in a world of keen competition.

CONCLUSION

The conviction which I have tried to express in the title of this address is that the history of an organization, as that of a person or a country for that matter, does not advance in a steady straight-line march but progresses by steps varying in size and depending on or at least influenced by the characteristics of individuals involved. This address has dealt mostly with men and events in the early history of ASP in the hope that our younger, more recent members might become somewhat better acquainted with them. I have emphasized the lighter vein and its frequent expression in poetic language; opinions and facts so expressed are always more easily accepted than plain, unvarnished truth. Surely, the ability to make fun of oneself or to make fun of other persons in a form which stimulates mirth rather than anger is a talent all too uncommonly developed. Should you say it would have been more appropriate to entitle this "tidbits" of history rather than "stepping stones," my alibi would be that I sent in the title before the paper was written. I wonder if any other ASP member has ever done that?

The preceding presidential addresses have been sorted according to the categories of interest of the individuals. If it seems I have broken with precedent in this discussion, my excuse is that the history of ASP has always been one of my main interests which has of course been heightened during my presidency. I take pride and should like to express my appreciation that you members added me to the list of presidents of the American Society of Parasitologists.

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It is felt unnecessary to provide a list of titles of presidential addresses and place of publication; the date when the address was delivered is given in the text. All published addresses appeared soon after presentation in the Journal of Parasitology, with the following three exceptions which were published in *Science*: That of H. B. Ward in the Sept. 10, 1926 number; that of C. W. Stiles in the February 25, 1927 number and that of N. A. Cobb in the Jan. 9, 1931 number.

NATURALLY OCCURRING *PLASMODIUM* AND *HAEMOPROTEUS* INFECTION IN THE COMMON PIGEON[1]

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Levi (1941) states that *Plasmodium relictum* must be very rare in nature (among pigeons), since it has been found (in America) in only one free common pigeon and the vector is unknown. The single case was a young pigeon observed at Peru, Nebraska, by Coatney (1938), from which stemmed the so-called l-p strain of the parasite (Huff, Boyd and Manwell, 1942). Very recently 2 cases from lofts 4 miles apart in the Sacramento area of California have been observed by Mathey (1955). Soberon y Parra and Perez Reyes (1956) isolated a strain of *P. relictum*, "IE", from a naturally infected pigeon in Mexico, evidently several years ago. Redmond (1943, 1944), Huff and Coulston (1946) and Coulston and Huff (1947) have adduced arguments for the better adaptation of Coatney's strain to the canary than to the pigeon, leading to the suggestion it may have come originally from passerine birds.

Haemoproteus columbae Kruse, 1890, transmitted by the hippoboscid fly *Pseudolynchia canariensis*, is a common parasite of pigeons in tropical, subtropical, and even at times southern temperate zones, but occurs in Northern States only under exceptional circumstances (*cf.* Drake and Jones, 1930, who noted it in Iowa). Morphologically, at least, it seems to be the same as *H. maccalumi* Novy and MacNeal, 1904, of the mourning dove. *H. sacharovi* Novy and MacNeal, 1904, occurring in mourning doves, was found in 3 common pigeons (1 adult and 2 squabs) at Peru, Nebraska, by Coatney and West, 1940. Transfer of this species from the dove to a pigeon had previously been accomplished by Huff (1932), using *Pseudolynchia canariensis* for the intermediate and transmitting host.

MATERIALS AND METHODS

One of us (W.F.H.) maintains a colony of pigeons on his home lot in Gilbert, Iowa. The birds are kept in small pens enclosed in open meshed chicken wire that would not hinder the free passage of mosquitoes or most other flying insects. While dressing squabs, evidence of parasitism with *Plasmodium* (enlarged and pigmented spleens, pigmented livers and body fat) and with *Haemoproteus* (enlarged, purplish spleens) has occasionally been noted by him. It was his interest in these gross abnormalities, which he properly ascribed to the activities of blood parasites, that led him to invite the cooperation of the other 2 authors.

The survey involved 3 procedures: (1) Preparation and microscopic examination of stained blood smears of the squabs that showed the suggestive gross pathological changes already noted; (2) direct microscopic examination of stained blood smears of all the birds in this colony and also of a number of free or so-called barn pigeons taken in Central Iowa; (3) isodiagnosis, to be explained later.

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RESULTS

1. *Direct examination of stained blood films from slaughtered birds.* Enlarged spleens and abnormal gizzard muscles were noted in a number of squabs from the colony being dressed on August 8 and 20, 1952. Blood smears from these cases were sent to Dr. Clay G. Huff at the Naval Medical Research Institute, where he diagnosed some of them positive for *Haemoproteus sacharovi.* Again, on August 26, 1952, 20 smears of squabs and young stock were sent to Dr. Huff, who diagnosed 3 of them positive for *H. sacharovi.* A squab dressed on July 26, 1953, had an enlarged spleen and a granular gizzard. *Haemoproteus,* perhaps immature *H. sacharovi,* was found in the blood smear from this bird when examined in this laboratory. Scattered cases of splenic enlargement with or without gizzard granulations were noted through October 9, 1953, but blood smears were not made.

The first case of enlarged spleen and gizzard lesions in 1954 was noted on August 4, but no blood smears were made. On September 11, 1954, a young bird when opened showed greatly enlarged and deeply pigmented spleen and liver and pigmented body fat, but the gizzard was normal. Three blood smears of this bird revealed a heavy infection of *Plasmodium relictum.* This particular squab's back had been denuded by a feather-pulling parent, and for this reason was unusually accessible to mosquitoes.

No special pathology was noted in any of the colony birds dressed in 1955. It was in general a dry year seemingly without so many mosquitoes as usual.

An adult male common pigeon captured in Sumter, South Carolina, by W. L. Hollander in August, 1955, had an enlarged pigmented spleen. A blood smear from it was mailed to our laboratory, where it was stained and examined microscopically. Heavy infection with a *Haemoproteus* was noted. The species, definitely not *H. sacharovi,* was probably *H. columbae.*

2. *Direct examination of blood smears from live birds confined in the colony and from free birds.* Blood smears were made on a total of 221 pigeons during September and October, 1955. Of these, 190 were confined in the Gilbert colony and 31 were free adult pigeons taken in barns in Central Iowa. The hatching dates of the colony pigeons had been recorded, and their ages and distribution were known to be as follows: 10 days–6 weeks, 26; 6 weeks–1 year, 27; 1–2 years, 11; 2–3 years, 30; 3–4 years, 44; 4–5 years, 15; 5–6 years, 8; 6–7 years, 13; 7–8 years, 12; 8–9 years, 1; 9–10 years, 3. Of the youngest group, 2 were 10 days old, 1 was 15 days, 5 were approximately 3 weeks, and the rest were over 4 weeks.

None of the 221 pigeons was found to harbor microscopically demonstrable *Plasmodium, Haemoproteus, Leucocytozoon, Trypanosoma,* microfilariae, or other haemotozoa.

3. *Isodiagnosis* (*cf.* Sergent, 1920). Since direct examination had failed to detect haematozoa in live pigeons of this vicinity, isodiagnosis was tried out on samples from the confined and free pigeons that were seemingly without parasitemia in an effort to uncover so-called latent, occult, chronic, cryptic, or subpatent infections. The blood of the "suspect" bird was injected intravenously into a clean (previously uninfected) bird, instead of intraperitoneally as Sergent (1920) had done. Of the genera of haematozoa more or less commonly occurring in birds, only *Plasmodium* and *Trypanosoma* could confidently be expected

to reproduce in the transfused clean birds, though there is literature evidence (Lastra and Coatney, 1950) that *Haemoproteus* might also be transmitted early in the infection by direct blood inoculation. Another blood smear was made of each tested bird immediately before the test blood was drawn, all of which were negative upon microscopic examination.

In the first test, 1 cc of blood was drawn from 15 adult pigeons kept in a cage adjoining a raspberry patch which, incidentally, had harbored numerous mosquitoes in former years. Seven samples were pooled in one vessel and eight in another. Approximately 2 cc of the pooled blood in each vessel were injected into each of 3 squabs. All 6 receptors were found to be harboring patent infections of *Plasmodium relictum* 8 days later.

In order to locate the sources of the infection more specifically, 1 or 2 cc of drawn blood from each of the 15 adult pigeons was injected directly into the wing vein of a clean squab. Three of the squabs developed patent infections of *Plasmodium relictum*. The 3 positive donors were found to be 2 4-year-old female pigeons and one 3-year-old male, all hatched and raised in the colony.

Examinations by isodiagnosis of 10 birds in other cages in the colony resulted negatively, as did similar tests of 14 of the previously mentioned barn pigeons.

The question naturally arose: How reliable is isodiagnosis as here practiced? A positive diagnosis, of course, speaks for itself. There were 3 aspects of the procedure that were subject to further inquiry. Had any of the transfused birds that were read negative developed subpatent infections? Were any of the negative transfused birds naturally refractory to infection? How constantly do viable parasites appear in the blood of birds with residual infections, and do such hosts ever spontaneously eliminate the last vestige of the *Plasmodium* infection from their bodies? Our investigations on these points were limited but, nevertheless, quite illuminating.

The transfused squabs which had failed to manifest patent infections of *P. relictum* were kept in the laboratory for several months without becoming positive on direct examination. Finally, 12 of them were divided into 6 pairs, and each member of a pair was transfused with 1 cc of fresh blood from 1 of 6 latent birds; i.e., birds which formerly, but no longer, harbored demonstrable parasites in their blood. All but 2 of the 12 manifested parasitemia within 7 days. The 2 negatives had been transfused with blood from the same supposedly latent pigeon.

Two cc of blood drawn from each of the 2 seemingly refractory transfused birds 15 days after transfusion did not transmit the infection when injected into 2 clean squabs. In order to test the susceptibility of the donors, they were injected intravenously with small doses of patent blood. Both of them promptly developed patent infections of *P. relictum,* and thus became exonerated of culpability. Thus the explanation of the apparent failure of isodiagnosis was narrowed down to the donor bird known to have experienced infection. Had it spontaneously eradicated the parasite from its body?

Two cc of blood were drawn from this pigeon, which 15 days previously had donated the blood that failed to transmit the infection to 2 transfused squabs, and it was injected into a clean squab. Nine days later malarial parasites first appeared in the receptor bird.

DISCUSSION AND SUMMARY

There has been put on record one patent, naturally occurring infection of *Plasmodium relictum* in the common pigeon (*Columba livia*), in a nestling squab from a colony at Gilbert, Iowa, as well as a number of infections of *Haemoproteus sacharovi* in squabs in the Gilbert colony. No haematozoa were noted for the fall of 1955 in reading stained blood films from 221 Central Iowa pigeons ranging in age from 10 days to 9 years, but *Haemoproteus columbae* (?) was found in a blood smear from a free, adult pigeon captured at Sumter, South Carolina. Three latent infections of *Plasmodium relictum*, however, were uncovered among 39 of these microscopically negative birds by using the method of isodiagnosis, all in birds hatched in former years when mosquitoes were obviously more numerous.

The opportunity arose for making a limited test of the reliability of isodiagnosis. It is to be recalled that Sergent, the originator of the procedure, in his first report had detected 16 out of 17 known (presumably) cases of *P. relictum* in passerine birds by its use. In a limited simulated test with 6 pigeons known to have become latent after exhibiting parasitemia, 5 were "detected" with the first transfusion to the clean squabs; hence, there was 1 failure in 6 trials. The 2 transfused birds failed to infect other clean squabs when their blood was passed, and they later acquired the infection when inoculated with a small amount of known positive blood. It seem undeniable, then, that they were susceptible when transfused, and had not received parasites at that time. It naturally follows that the 2 cc of blood drawn from the donor bird did not contain viable parasites. Two cc of blood drawn 15 days later, however, did produce infection when injected into a squab, but the first parasites were not seen until 9 days had passed. This experience exposes a weakness in the efficacy of isodiagnosis when the residual infection in the suspect bird is at almost the lowest imaginable level. It can only be surmised that in our survey one or more such minimal infections were not detected.

Evidently, then, the bird in question had almost experienced spontaneous eradication of the malarial infection. If a pigeon can come so close to it as this one did, it seems not unlikely that in rare instances a sterilizing immunity could terminate the latent infection.

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RESEARCH NOTE

A COMPARISON OF THREE STAINING TECHNIQUES FOR PROTOZOAN PARASITES AS APPLIED TO PVA-PRESERVED FECAL SPECIMENS

In the spring of 1955 the writer spent several weeks on a coffee plantation in Chiapas, Mexico, and while there carried out a survey for intestinal parasites on the permanent residents of the plantation. Specimens were obtained from 115 of approximately 200 inhabitants, including children of all ages. After direct examination, the specimens were preserved in polyvinyl alcohol (PVA) preservative solution (Brooke, M. M. and Goldman, M., 1949, J. Lab. and Clin. Med. **34:** 1554–1560) for subsequent staining.

This population was found to be heavily infected with intestinal protozoa, and accordingly afforded an excellent opportunity to assess the relative efficiency of several permanent staining techniques, as applied to PVA-preserved material. Several slides were made from each specimen and stained with a conventional iron-hematoxylin stain, with trichrome (Wheatley, W. B., 1951, Am. J. Clin. Path. **21:** 990–993), and with modifications of the acid-fuchsin light-green stain of Lawless (1953, Am. J. Trop. Med. and Hyg. **2:** 1137–1138).

Lawless' stain, described as a rapid fixative and stain for protozoa in fresh stool specimens, has given excellent results in routine use in this laboratory. Unfortunately, when applied to PVA-preserved material the stain was found to be most erratic, and various modifications of the technique did not result in consistently good performance. Results of examination of the series of 115 specimens, stained with iron-hematoxylin and with trichrome, are given below.

Parasite	Total number positive	Found only on	
		trichrome	hematoxylin
Entamoeba histolytica	34	3	6
Entamoeba coli	40	5	4
Endolimax nana	31	6	6
Iodamoeba bütschlii	14	1	5
Dientamoeba fragilis	2	2	–
Giardia lamblia	17	5	2
Chilomastix mesnili	2	1	–
Trichomonas hominis	3	–	1
Enteromonas hominis	1	–	–

While the majority of infections with each of the protozoan parasites was detected in both trichrome and hematoxylin stains, some were found on only one stain or the other. The differences between the two methods were small, and did not consistently favor one method over the other. The additional number of positives found by a combination of the two techniques was not greater than that which has been demonstrated to be obtained by repetition of the iron-hematoxylin stain, and might be expected from examination of two trichrome-stained slides. The trichrome method is becoming increasingly popular in clinical laboratory use because of its simplicity, and the results obtained in the present series indicate that there is little to choose between it and iron-hematoxylin, from the standpoint of accuracy of diagnosis.

Appreciation is expressed for the facilities extended by Sr. Bertoldo Bernstorff, manager of Finca Esmeralda, Pueblo Nuevo, Chiapas, and by the personnel of the Instituto de Salubridad y Enfermedades Tropicales, Mexico, D. F., and the Centro Médico, Huixtla, Chiapas.—EDWARD K. MARKELL, *Department of Infectious Diseases, School of Medicine, University of California, Los Angeles, California.*

EFFECTS OF CORTISONE ON CELLULAR INFLAMMATION IN THE MUSCULATURE OF MICE GIVEN ONE INFECTION WITH *TRICHINELLA SPIRALIS*

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The musculature inflammation caused by *Trichinella spiralis* has been studied in a variety of hosts (Gould, 1945), but little is known about the specific effects of the cellular infiltration in relation to immunity. During an experiment in which the effect of cortisone on single infections of *T. spiralis* was tested (Coker, 1955), samples of muscle tissue were taken at intervals following infection. The histopathologic findings relating to the development of cellular infiltration in the cortisone-treated and control animals, in response to invasion of the musculature by the larvae, are now presented. The results have a bearing upon certain aspects of immunity.

Previous papers (Coker, 1955, 1956a, and 1956b) have discussed studies by other workers on the relation of cortisone to infections with *T. spiralis*. In addition to these, Pollay, *et al* (1954) reported that, in rats infected with Trichinella, the eosinophilia was greatly reduced by the administration of ACTH.

MATERIALS AND METHODS

The details of the materials and methods and of the experimental design have been indicated previously (Coker, 1955). In brief, there were 4 groups of mice infected with 200 larvae of *T. spiralis* per mouse. One control group was given no injections and another was injected with 0.85 per cent NaCl. The mice of the 2 experimental groups were given daily injections of cortisone, one to the 14th day and the other to the end of the experiment on the 30th day after infection. The injections commenced 2 days prior to infection. The daily dosage of cortisone was 0.5 mg, given as a single subcutaneous injection in a volume of 0.05 ml.

Portions of the diaphragm, and in some cases of the tongue, of the mice of all groups were preserved in Bouin's fixative at 14, 21 and 30 days following infection. There were tissue samples from 5 mice of each group at both 14 and 21 days, and from 1 mouse of each group at 30 days. The tissues were sectioned in paraffin at 10 microns, stained with hematoxylin and eosin and mounted in balsam.

EXPERIMENTAL RESULTS

At 14 days after infection tiny larval worms were observed in the musculature of all groups, but there was no evidence of inflammation in any group. At 21 and 30 days a striking cellular reaction was observed in all groups except those re-

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ceiving cortisone throughout the experiment. The cellular reaction in the 2 control groups appeared to be the same, and the reaction was more striking in the diaphragm than in the tongue. On the basis of these various observations representative photomicrographs were prepared (Plates I–III).

In samples from both the uninjected and the saline-injected controls at 21 days after infection (Pl. I, Fig. 1) there was an acute general myositis with participation by lymphocytes and other mononuclear leukocytes, as well as by neutrophils and eosinophils. In samples taken at 21 days from mice treated with cortisone to the 14th day there was also a striking general myositis (Pl. II, Fig. 1) but eosinophils were less abundant than in the controls. In 21-day samples from mice treated with cortisone continuously there was little or no evidence of cellular infiltration (Pl. III, Fig. 1).

In both control groups the general cellular myositis had subsided partially by the 30th day and there appeared to be a tendency for consolidation around the worms; where dead worms were observed there was an intense local cellular reaction (Pl. I, Fig. 2). In the sample at 30 days from a mouse treated with cortisone to the 14th day there was an acute general myositis similar to that observed in the controls 21 days after infection (Pl. II, Fig. 2). However, in the sample taken 30 days after infection from a mouse treated continuously with cortisone there was no general cellular infiltration (Pl. III, Fig. 2); a few neutrophils and mononuclears of abnormal appearance were noted. There was a small accumulation of cells around some of the worms but the numbers were in marked contrast with those observed in the control groups.

DISCUSSION

The above results show that the characteristic cellular reaction to *T. spiralis* larvae in the musculature of the mice was initiated between 14 and 21 days after initial infection and persisted for at least 30 days after infection. Injecting cortisone daily for only 13 days after infection did not prevent the development of a cellular reaction, which at 21 and 30 days was similar to that observed in the controls. However, by continuing the daily cortisone injections to the end of the experiment the cellular reaction observed at 21 and 30 days was suppressed almost entirely. These observations show that cortisone exerts in the musculature of mice an effect upon the cellular components of inflammation similar to that noted in the intestinal tissue (Coker, 1956b). Also, the present observations confirm the reports that such inhibitory effects are temporary and cease to operate soon after the hormone injections are discontinued.

It is interesting in relation to immunity that the cellular reaction in the musculature approached the normal level within 8 days after discontinuing the cortisone injections on the 13th day. Assuming that the inflammation at 21 days required, at least, a day or two to reach the acute phase observed, it may be stated that in these mice acute inflammation was present for at least 10 days when, 30 days after infection, the last observation was made. Despite this long period of acute inflammation, the number of larvae recovered from the musculature 30 days after infection did not differ statistically from that recovered from the other cortisone-injected group (Coker, 1955) that showed almost no inflammation. It is important to add that at 14, 21, and 30 days after infection the counts of adult worms from the intestines of these two groups likewise were similar (Coker, *l.c.*), which would

indicate that similar numbers of larvae were produced in, as well as recovered from, both groups. It is clear, therefore, that the acute muscular inflammation observed in the one cortisone-injected group did not result in a demonstrable reduction in the number of larvae recovered 30 days after an initial infection. This differs strikingly from observations in the intestine where inflammation is associated closely with a sudden and significant loss of adult worms (Larsh and Race, 1954; Coker, 1956b).

At first thought, the present observations would seem to support the view that the difference in the number of *Trichinella* larvae recovered from the musculature of experimental animals is due entirely to the persistence and the reproductive potential of the females in the intestine (both influenced by the immunity of the host), and is not related in any way to the action of protective mechanisms in the muscles. However, the present findings do not prove this point, since an effect of muscle immunity in reducing the numbers of larvae may be a long-term process and thus undetectable at 30 days after initial infection. Such an immunity effect, to conform to the classical concept, would involve both antibody action and cellular action (Larsh and Race, 1954). Recently, Chute (1956) reported that in rats given immune serum after the intestinal phase of the infection was almost completed, there was no reduction in larval worm recovery at 45 days, but the larval worms were significantly shorter in length as compared with those in controls. Moreover, in the control mice of the present experiment an occasional dead larva was seen, possibly representing a direct result of muscle immunity. Further work is necessary before definite conclusions can be drawn, particularly in regard to the role of the cellular reaction in muscle immunity. Cortisone, because it can be used to manipulate both the cellular reaction and immunity effects, may prove to be the best tool to use in future studies (Coker, 1955, 1956a, 1956b).

SUMMARY

Daily cortisone treatment of mice for 30 days after an initial infection with *Trichinella spiralis* resulted in almost complete suppression of the normal cellular infiltration into the musculature in response to invading larval worms. A shorter period of treatment with cortisone, terminating on the 13th day after infection, did not prevent the development of a striking general myositis as measured at 21 and 30 days after infection. Despite this striking cellular response there was not a reduction in the number of larvae recovered from the musculature. Therefore, if this response is related to an immune action against the larvae, it requires longer than 30 days to produce demonstrable effects.

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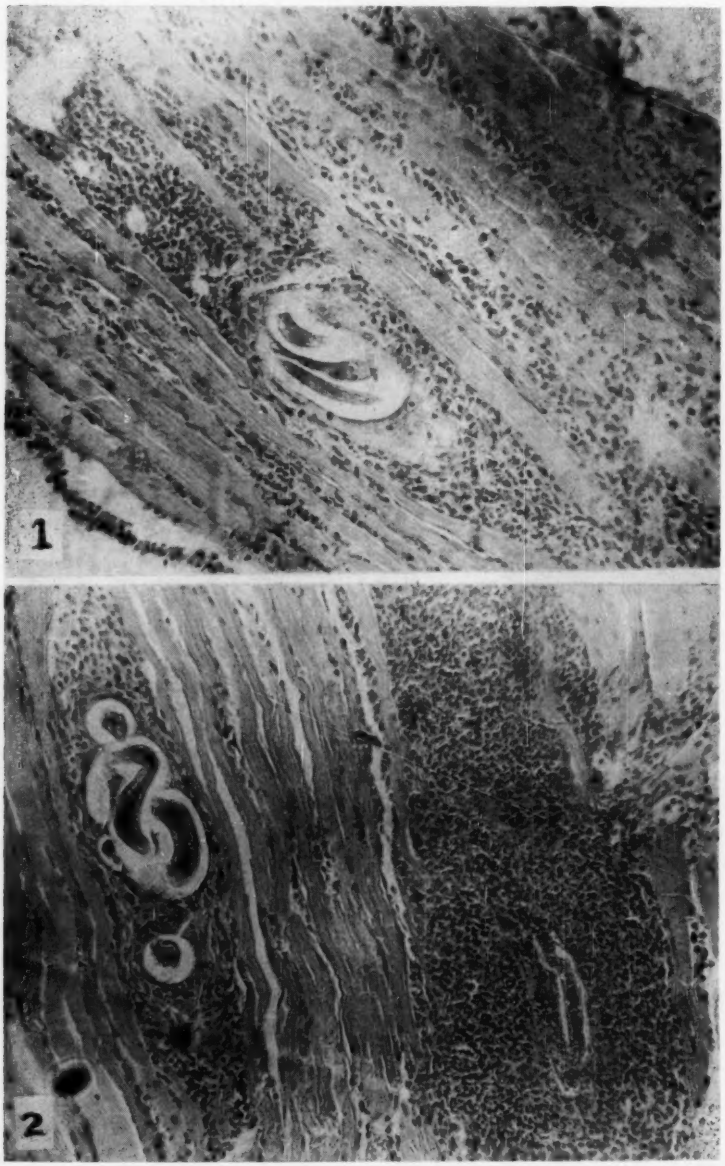

PLATE I. Uninjected control. There was an intense myositis at both 21 and 30 days after infection. Note striking cellular accumulation around dead larval worm in Fig. 2 (30 days).

EXPLANATION OF FIGURES

Cellular infiltration in response to invasion of the diaphragm muscle by larvae of *Trichinella spiralis* in control and cortisone-treated mice. All photographs were taken at the same magnification, using a compound microscope with 10× ocular and 10× objective. Figure 1 on each plate represents samples taken at 21 days after infection; Figure 2, at 30 days following infection. H. and E. stain.

PLATE II. Cortisone-injected to day 14 after infection. There was an intense myositis at both 21 and 30 days following infection.

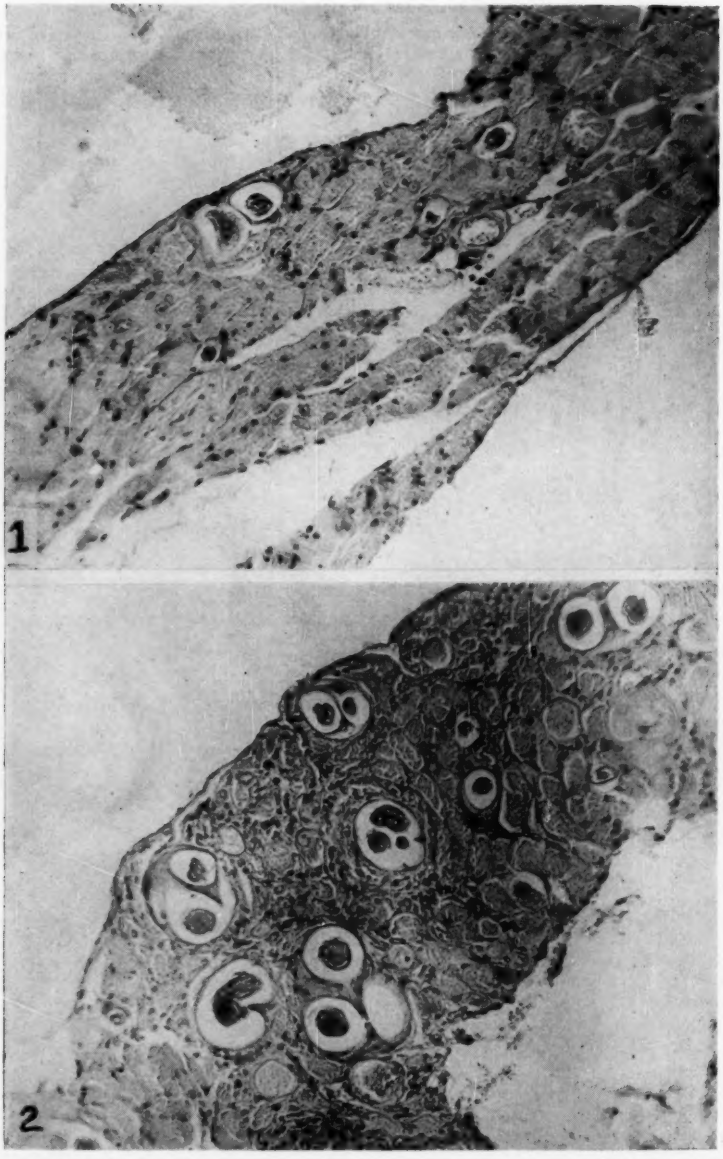

PLATE III. Cortisone-injected throughout the experiment. The cellular infiltration was almost totally suppressed as measured at both 21 and 30 days following infection.

STUDIES ON THE LIFE HISTORY OF *HYMENOLEPIS CITELLI* (McLEOD, 1933) (CESTODA: CYCLOPHYLLIDEA)

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The close resemblance of adults of *Hymenolepis citelli* (McLeod, 1933) to those of *Hymenolepis diminuta* (Rudolphi, 1819) has been noted by various workers. On the basis of characteristics of the adult worm, Rausch and Tiner (1948) suggested that *H. citelli* should be considered a synonym of *H. diminuta*. In view of the data available at that time this was a reasonable conclusion. Subsequent examination and analysis of numerous specimens of *H. citelli* from ground squirrels and their comparison with specimens of *H. diminuta* from Norway rats (Voge, 1952) showed that these two forms differed sufficiently to warrant provisional retention of *H. citelli* as a specific entity.

It was thought that a knowledge of the life cycle and larval development of *H. citelli* should further clarify the status of *H. citelli* and *H. diminuta*. Results obtained from these studies are reported here.

I wish to express my appreciation to Dr. Walter E. Howard, University of California, Davis, Mr. Henry Childs, Compton College, Compton, and Mr. Raymond E. Ryckman, School of Tropical and Preventive Medicine, Loma Linda, California, for their kind help in procuring live ground squirrels used in this study.

MATERIALS AND METHODS

Experimental animals used in the life history studies were the following: Two uninfected ground squirrels (*Citellus beecheyi*) obtained February, 1954, at the San Joaquin Experimental Range, O'Neals, Madera Co., California. These squirrels were kept in the laboratory for more than one year; no tapeworm ova were found in their feces at any time during this period. Two *Citellus beecheyi*, each with a naturally acquired infection of *Hymenolepis citelli*, were obtained from Loma Linda, San Bernardino Co., California. In addition five hooded rats (Long-Evans) and five albino laboratory mice were used in experimental infection. The diet of all rats, mice and ground squirrels consisted of "Purina Laboratory Chow."

Laboratory-reared adult *Tenebrio molitor* and *Tribolium confusum* were used as intermediate hosts. The Rice Institute strain of *Hymenolepis diminuta* was carried in laboratory rats and in tenebrionid beetles for comparison with *H. citelli*. Cestode ova were concentrated from the feces of the definitive hosts and fed to previously starved beetles (Millemann, 1955) with small pieces of apple or raisin. Larval and adult cestodes were studied while alive. Permanent mounts from Bouin's fixed specimens stained with Ehrlich's haematoxylin were also examined.

DEVELOPMENT OF *Hymenolepis citelli* IN THE INTERMEDIATE HOST

The mature cysticercoid: Mature and infective cysticercoids of *H. citelli* were obtained in *Tribolium confusum* and in *Tenebrio molitor* 14 days after infection. The infection rate in these beetles kept at room temperature (26–29° C) was about 50%.

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As many as five cysticercoids were seen in one *Tribolium,* three or four being the usual number per infected beetle. In *Tenebrio,* cysticercoids were more numerous but the infection was not as heavy as it frequently is with *H. diminuta.*

While the mature cysticercoid of *H. citelli* (Figs. 7, 8) resembles that of *H. diminuta* (Fig. 9) in body size and shape, consistent differences may be observed. Table 1 shows that the diameter of the scolex and its surrounding membranes in *H. citelli* is considerably larger than it is in *H. diminuta.* As seen in Figures 8 and 9, this size difference is due to the spacing and thickness of the membranes enclosing the scolex, rather than to a size difference in the scolices proper. Aside from

TABLE I.—*Size ranges and averages of live, mature cysticercoids of* H. citelli *and* H. diminuta *reared in* Tribolium confusum

	Body length without tail (microns)	Body width (microns)	Scolex with enclosing membranes (microns)
H. citelli 14 days	340–382 (358)	273–382 (300)	212–230 × 221–273 (216 × 243)
H. citelli 20 days	340–382 (355)	255–314 (271)	195–221 × 221–255 (211 × 235)
H. diminuta 20 days	348–425 (382)	221–332 (255)	145–178 × 178–230 (161 × 194)

minor differences in body shape, the mature cysticercoids of these two species may be distinguished in several respects. In *H. citelli,* the external membrane enclosing the scolex is surrounded by several concentric layers of membranous material (Fig. 8). In *H. diminuta* these layers are absent (Fig. 9). Just below the surface of the cysticercoid of *H. citelli* there is a dense layer of deeply staining cells, which does not extend into the tail region (Figs. 7, 8). These cells are absent in *H. diminuta* which has a dense layer of fine, long, hair-like structures projecting from the surface of the cysticercoid (Fig. 9). These structures are seen in live as well as in fixed and stained material; they are absent in *H. citelli.* The anterior invagination in the cysticercoid of *H. citelli* is very shallow and frequently does not extend below the concentric layers surrounding the scolex. In *H. diminuta,* one usually sees a wide continuous canal which extends from the surface of the cysticercoid to the scolex proper.

Structure and size of the tail vary considerably in *H. citelli* cysticercoids. The tail may be short or long, wide and thick or very narrow, or it may be composed of several distinct parts (Fig. 7). As far as could be determined these differences do not affect infectivity of the cysticercoids.

Egg structure and development of the cysticercoid: The mature egg of *H. citelli* (Fig. 1) is thin-shelled and ovoid. It contains the onchosphere within an onchosphere coat and a thin egg membrane. Comparison with the egg of *H. diminuta* reveals several differences. The polar thickenings of the onchosphere coat frequently seen in *H. diminuta* (Fig. 2) are absent in *H. citelli.* In *H. citelli* however, one observes polar groupings of granules in the space between the onchosphere and its coat. These granules are absent in *H. diminuta.* The distance between egg membrane and onchosphere coat is relatively small in *H. citelli* when compared to *H. diminuta.* This difference is not due to unequal amounts of folding within the egg but to actual difference in size of these egg membranes. Examination of live onchospheres with surrounding coats and egg membranes without egg shells revealed that in *H. citelli* the space between onchosphere coat and egg membrane

is 4–5 microns wide (Fig. 4), while in *H. diminuta* it is 22–34 microns wide (Fig. 3). These differences are consistent and may be observed after applying gentle pressure on the coverslip of a preparation of live eggs. The resultant break in the egg shell will cause extrusion of the onchosphere surrounded by the egg membrane.

The developmental stages of *H. citelli* cysticercoids in beetles, although similar to those of *H. diminuta* during the first few days, exhibit some major differences in the latter half of the growth period. The onchosphere of *H. citelli,* which has penetrated the gut wall of the beetle about 24 hours after entry, develops into a compact although somewhat fragile structure which soon loses the onchosphere hooks. At the end of five days (room temperature 28–32° C) the appearance of the larva is as shown in Figure 5. There is a well circumscribed cavity with a wall which is continuous at the posterior end but interrupted anteriorly. Some differentiation may be observed anterior to this cavity. The surface of the larva is smooth, without indentations or invaginations. No tail development has occurred. As growth continues, the larva increases in size and the wall which surrounds the central cavity becomes rigid and uninterrupted except for an opening at the anterior end (Fig. 6, seven day stage). Similarly, a second outer membrane is fully formed except for an anterior opening. Numerous granules are seen in the anterior half of the cavity, but the scolex is as yet undifferentiated. The external surface of the larva is smooth, without anterior protuberances or clefts. Posteriorly, tail formation is under way.

The next step in development is the closure of both openings of the internal membranes. At nine days only a very small anterior invagination is seen on the outer membrane enclosing the scolex. The latter is well differentiated and motile; sucker formation is under way. A small infolding on the external surface, similar to that shown in Figure 7, is present at the anterior end of the larva. The tail is fully formed. In external appearance, the larva now closely resembles the mature cysticercoid shown in Figure 8.

External development and subsequent invagination of the scolex, as seen in *H. diminuta,* was never observed in *H. citelli.* The structure of the mature cysticercoid which in contrast to *H. diminuta* has a very shallow anterior invagination also would support the contention that the scolex of *H. citelli* develops without the secondary invagination observed in *H. diminuta.*

DEVELOPMENT OF *Hymenolepis citelli* IN THE DEFINITIVE HOST

Infection experiments with mature cysticercoids were carried out with ground squirrels, Long-Evans rats and albino mice. Cysticercoids were obtained by dissection of beetles in saline solution. The host to be infected was then lightly anesthetized with ether and the cysticercoids fed by pipette. Beginning 12 days after infection, the feces of the infected animal were checked daily for the presence of eggs.

In the two adult ground squirrels which had been given five and four cysticercoids each, eggs first appeared in the feces 18 days after infection. In adult Long-Evans rats which were fed similar numbers of cysticercoids on the same day as the two ground squirrels, eggs appeared in the feces 19–20 days later. One of the rats which was autopsied with one of the ground squirrels 18 days after infection, contained three worms, each about one half the size of those found in the ground

squirrel. The latter harbored five mature worms with gravid proglottids while the worms from the rat had no gravid proglottids, although they were otherwise normal. A second Long-Evans rat autopsied after eggs had appeared in the feces, yielded three worms, each much smaller than those from the ground squirrel.

Subsequently, two half-grown Long-Evans rats were infected with cysticercoids. In these, development proceeded much faster and eggs were first seen 16 days after infection. Similarly, two of five albino mice all infected on the same day with two cysticercoids each, had eggs in the feces 16 and 14 days after infection. Two small but otherwise normal worms were recovered from these mice. The inconsistent results obtained with regard to time of development in the definitive host cannot be explained at present. Further studies are needed to explain the relatively short time between infection and egg production in young rats and in mice as compared to the longer period in adult rats and ground squirrels. The smaller size of the worms in rats and mice is not the only factor, since in adult rats which also contained relatively small worms, 19–20 days of growth were required before egg production occurred.

It should be emphasized that no significant structural differences, other than body size, were observed in adult worms obtained from the different host species.

Mr. Alvin Rothman in Dr. C. P. Read's laboratory at the Johns Hopkins University has now successfully established my strain of *H. citelli* in hamsters (personal communication).

DISCUSSION

The results obtained from the life history studies on *Hymenolepis citelli* support the contention (Voge, 1952) that this species is distinct from *Hymenolepis diminuta*. In addition to differences in the pattern of variation of testis position and in the types of developmental abnormalities which, for adults of *H. diminuta* at least, remain consistent in different host species (Voge, 1952a), it is apparent from the studies reported here that the two species differ in the structure of their eggs and the mature cysticercoids. Furthermore, there appear to be distinct differences in the larval development of the two species. The external formation and subsequent invagination of the scolex described for *H. diminuta* by Joyeux (1920) and also seen by me, was not observed in developing cysticercoids of *H. citelli*. It is of interest that while the adults of *H. citelli* and *H. diminuta*, on cursory examination at least, are indistinguishable from each other the differences between mature cysticercoids are much more readily apparent. It is possible that many *H. diminuta*-like cestodes reported from various wild rodents may, after their life histories have been studied, be assigned to different and as yet undescribed hymenolepidid species.

The size differences of adults of *H. citelli* in different host species are probably in a general way related to the size of the host species in which they have developed. This has been observed to be true for *H. diminuta* (Read and Voge, 1954).

SUMMARY

The life cycle of *Hymenolepis citelli* (McLeod, 1933) has been experimentally demonstrated in the laboratory. Infective cysticercoids were obtained in laboratory-reared *Tribolium confusum* and *Tenebrio molitor*, in 14 days. Fully mature worms were obtained in ground squirrels (*Citellus beecheyi*) 18–19 days after infection. In addition, laboratory rats and mice were also infected. The differences and sim-

ilarities of the larval stages of *H. citelli* and *H. diminuta* are discussed. Observations on the life cycle of *H. citelli* confirm the view that this form is distinct from *H. diminuta*.

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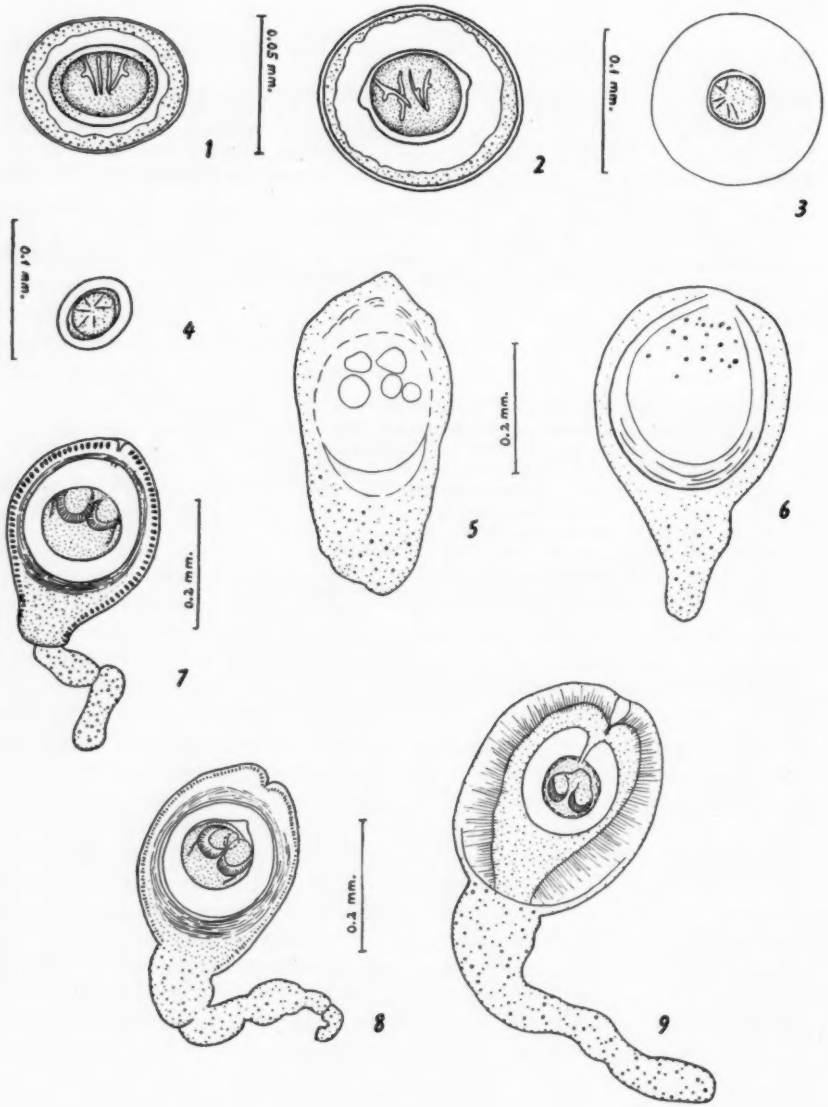
Plate I

Explanation of Figures

All drawings made with the aid of a camera lucida.

Fig. 1. *Hymenolepis citelli;* live embryonated egg.
Fig. 2. *Hymenolepis diminuta;* live embryonated egg.
Fig. 3. *H. diminuta;* live onchosphere with egg membrane.
Fig. 4. *H. citelli;* live onchosphere with egg membrane.
Fig. 5. *H. citelli;* larval stage (five days).
Fig. 6. *H. citelli;* larval stage (seven days).
Fig. 7. *H. citelli;* mature cysticercoid (fourteen days).
Fig. 8. *H. citelli;* mature cysticercoid (twenty days).
Fig. 9. *H. diminuta;* mature cysticercoid (twenty days).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HUMAN COCCIDIOSIS IN SOUTH CAROLINA

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National Institutes of Health, National Institute of Allergy and Infectious Diseases[1]

Recently reported findings may indicate either that the coccidia of man are of wider distribution and greater prevalence than was formerly considered to exist, or the infection may have become more widespread in recent years. In the United States Routh, McCroan, and Hames (1955) and Beck, Stanton, and Langford (1955) have reported indigenous cases for the first time in Georgia and Florida. Jones (1955) reported a case in an American seaman in Baltimore, Maryland, but does not clarify its origin. As far as we can determine from the literature no cases have been reported from South Carolina. The present report will describe 4 cases in a South Carolina institutional population and a case in a laboratory worker.

OBSERVATIONS

Institutional Cases

Because of a high incidence of diarrheal disorders during the summer of 1955 at the Pineland Training School for mental defectives a survey for intestinal parasites was done. An effort was made to examine 2 fecal specimens from each patient, although in some cases only a single specimen was obtainable. Each specimen was examined by direct saline and iodine smears and by zinc sulfate flotation. Of 95 inmates examined, 4 (4.2 per cent) were found infected with *Isospora*.

The species of parasite found is designated as *Isospora belli* Wenyon, 1923 following the reasoning of Elsdon-Dew and Freedman (1953). The oocysts ranged in length from about 28 to 36 microns and in width about 13 to 17 microns, with a mean size of 31 by 14 microns. The oocysts appeared to have a slight to moderate constriction at a point about 5 to 7 microns from one end. The oocysts were usually passed containing a single sporoblast, which divided in a short time into 2 sporocysts, usually measuring about 11 by 9 microns. There was no oocystic residual body; the residual body of the sporocyst was compact and usually had the 4 sporozoites clustered around it. Sporozoites matured readily in 4 to 5 days in a solution of 2 per cent potassium dichromate.

Table I presents some pertinent data concerning the 4 cases found at the school for mental defectives. All cases were in Negro males, 4, 6, 12, and 22 years of age. After detection of the parasites 2 to 5 specimens per week from these patients were examined. In 1 of the patients no further oocysts were found, but in the others the oocysts persisted in the stools intermittently for 83 to 120 days. In these cases the numbers of oocysts passed became very small; toward the end of the observation period they were discernible only with zinc sulfate flotations and then only occasionally and in small numbers.

Loose stools were frequently associated with the presence of oocysts, especially during the early stages of known infection. The stools were often of a light brown color and seemed to contain much fatty material. One of the cases (LBD) passed

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stools for several days, beginning about 10 days after discovery of the infection, which were dull to bright green in color and contained much mucus and undigested food (mostly appearing as coagulated milk proteins). It was not possible to obtain reliable clinical information on the infected patients during or prior to their period of known infection. Only 1 patient known to have the infection was debilitated to any extent and this one (LBD) was ill only during the few days that he passed the abnormal stools described above, although this period was preceded for about 10 days and followed for more than 2 months by loose or soft stools. Intervention in this case about 3 weeks following detection of the *Isospora* with a low dosage of puromycin (Stylomycin) (250 mg. b.i.d. × 4 days—total of 2 grams) had some effect on the other intestinal protozoa, but apparently did not eliminate the *Isospora* infection.

TABLE I. Isospora belli *in institutionalized patients and a laboratory technician*

Patient	Age	Prior length of residence in institution	Known persistence of *Isospora*	Other intestinal parasites present
M.S.	4	8½ months	1 day	*E. histolytica* *E. coli* *C. mesnili* *T. hominis* *G. lamblia*
L.B.D.	6	1½ months	120 days	*E. histolytica* *E. coli* *E. nana* *C. mesnili* *T. hominis* *G. lamblia* *T. trichiura**
C. H.	12	8½ months	83 days	*E. coli* *E. nana* *C. mesnili* *G. lamblia*
S.L.B.	22	9 years	115 days	*E. coli* *C. mesnili* *T. trichiura*
		1 case in laboratory technician		
A.B.	28	(Employed at institution for about 1 year)	50 days	None

* Not present during early examinations

Isospora in a Laboratory Worker

The individual involved (AB) was employed in the laboratory where fecal examinations were done on the above described cases of *Isospora* and where the oocysts were matured in potassium dichromate and used in animal experiments. However, he was not associated directly with intestinal parasite work, nor did he conduct his work in the same room. His visits to the room were casual, probably numbering 5 or 6 per day, and were of short duration. This technician was engaged in a project where specimens of blood for serological work were taken from patients on various institutional wards. This work included the school where the *Isospora* infections were found, but the technician last visited this school about 8 weeks prior to his first symptoms, at which time he took blood specimens from the 4 known infected cases.

This technician was a healthy white male, aged 28 years. On a Tuesday he began to have diarrhea and frequency of stools. The first opportunity to have a fecal examination was the following Monday. At this time many oocysts of *Isospora*

were found; no other intestinal parasites were present, nor have others been found subsequently. The patient continued to have loose or mushy stools for about 12 days after detection of the *Isospora;* for the next 2 months the stool pattern was normal with an occasional episode of soft stools. During the period of diarrhea the stool consistency was typical of that frequently described as accompanying *Isospora:* A light color, fatty consistency, and containing some mucus and undigested food.

A close check was kept on the patient to determine if a clinical course of the infection might be discerned. During the early stages of the infection, including the few days before fecal examination revealed the parasite, the patient showed some symptoms of possible significance. On the first day of symptoms (Tuesday) the patient experienced chills, a fever of 101.8° F, flatulence, severe anorexia, and loose, watery stools. On the following 2 days the anorexia and loose stools continued, but there was no fever. By Friday the anorexia was less severe; the patient continued with poor appetite for another week after the infection was found. No nausea or abdominal pain or tenderness accompanied the other symptoms. After return to a normal stool pattern the patient experienced no further symptoms, other than an occasional soft stool.

Oocysts of *Isospora belli* continued to be present in the feces for 50 days after the first detection. Toward the end of the period of observation the oocysts became very scarce and were found only after zinc sulfate flotation, and then in very small numbers.

Experiments in Laboratory Animals

Oocysts were matured in 2 per cent potassium dichromate solution and were given in large numbers to a variety of experimental animals. Mature oocysts were fed to 2 swine (120,000 each), 2 8-week-old dogs (40,000 each in 4 separate feedings of 10,000), and 2 rhesus monkeys (30,000 and 45,000). Oocysts were introduced intragastrically into 12 white mice (250 to 2,000 each), 4 white rats (500 to 6,000 each), 1 white rabbit (8,000) and 1 guinea pig (600). Establishment of infection in these animals was apparently unsuccessful; oocysts were not detected in the fecal material passed by these animals during the subsequent periods of examination: 1 month in the mice, rats, rabbit and guinea pig, 2 months in the dogs and 4 months in the swine and monkeys.

DISCUSSION

The origin of the *Isospora* infection in the institutional population studied is obscure. The cases must be considered indigenous, since it is known that none of the patients had left this area. Several factors point to the probability that the infection had been present in the population for some time. The patient (MS) showing the parasite only a single time was known to have suffered from diarrrheal disorders, sometimes severe, for about 3 months prior to detection of *Isospora.* Presence of *Isospora* oocysts in the stools of the other patients for as long as 4 months is suggestive that this patient may have carried the infection equally as long. Diarrhea was reported as frequent in the population during the 4 months prior to detection of the infection; the presence of this condition was one of the factors involved in the decision to examine the population.

The incidence in the population may have been much larger than detected. If the infections were in the terminal period it is likely that 1 or 2 routine examinations

would detect the parasite in only a few cases. In 1 of our cases (SLB), during the last 2 months prior to the final detection of the parasite, only 6 of 26 examinations were positive, and these frequently only on diligent search of a single preparation from a zinc sulfate flotation. Similarly in another (LBD) only 2 of 18 examinations were positive. It appears that the oocysts are passed in fair numbers only during the first month of apparent infection.

Many studies on *Isospora* of humans have indicated that oocysts are not found in the stools for periods in excess of a few days or weeks. Elsdon-Dew and Freedman (1953) report finding *I. hominis* in the stools of a patient for as long as 21 days and consider this (and 10 to 15 days) as "long periods." Matsubayashi and Nozawa (1948) report persistent passage of oocysts in stools for 32 and 38 days in 2 induced infections. Although the exact length of persistence is not noted in the 15 cases observed by Barksdale and Routh (1948) it is certain that oocyst passage was not observed longer than 24 days. Although it cannot be ruled out completely, it is unlikely that our extended cases (83 to 120 days) could be accounted for by repeated infections; the diminishing oocyst numbers seem to indicate that a single infection was capable of persisting for a considerable period. This long duration of oocyst passage is undoubtedly of significance in the epidemiology of the disease, especially when one also considers the long persistence of viable mature oocysts which probably occurs in fecal material, soil, water or other contaminated media.

The origin of the infection in the laboratory technician cannot be certainly established. It seems likely that he acquired the infection through his work or through his visits in the intestinal parasite laboratory. However, the infection cannot be attributed to any known specific incident or accident and none of the 4 persons routinely working in the intestinal parasite laboratory developed the infection. Although the presence of the parasite in this individual was not definitely established until nearly a week after symptoms began, it seems likely that the early symptoms were in fact associated with the infection.

The symptomatology of the infection as noted in the laboratory technician was similar to that described by others. A similar but more severe course was described by Matsubayashi and Nozawa (1948) in 2 volunteers, but these infections were induced by ingestion of 2,500 to 3,000 mature oocysts, which may have intensified the symptoms to some extent. Description by Barksdale and Routh (1948) of the symptoms common in 15 cases observed by them also show simliar characteristics. Symptoms seen in the institutional cases described above may have been related to the parasite, but intercurrent infection with numerous other parasite species rules out any real correlation.

The animal experiments conducted were not in large enough volume to be conclusive, but the results are suggestive that *I. belli* may not depend on any of the hosts tested as reservoirs. The finding of Routh *et al* (1955) of a dog infected with a coccidian similar in morphology to *I. belli* may indicate that the species is infective to human and canine hosts, but the negative results of our experimental feeding of oocysts to 2 puppies do not support this hypothesis. Strain differences conceivably could account for such a difference in host specificity.

The failure to infect simian hosts with the *Isospora* of man confirms the report of Foner (1939) who failed in similar trials in 3 *Macacus rhesus* monkeys. It appears probable that the rhesus monkey is not susceptible to *I. belli* and thus not of importance as a reservoir of infection.

SUMMARY

Four cases of *Isospora belli* infection were detected in a school for mental defectives. These are the first indigenous cases known to occur in South Carolina.

A fifth case occurred in a technician, possibly accidentally acquired in the laboratory. Symptoms attributable to the *Isospora* infection in this case are described.

Oocysts persisted in the stools of 3 of the institutionalized cases for 83, 115, and 120 days after their detection, and for 50 days in the laboratory technician.

Experimental inoculation, with mature oocysts, of 2 monkeys, 2 dogs, 2 swine, 12 mice, 4 rats, a guinea pig, and a rabbit failed to produce discernible infections.

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RESEARCH NOTE

TRITRICHOMONAS MURIS IN DESERT RODENTS OF UTAH

Doran (1953, J. Parasitol. **39:** 569) has briefly reviewed the occurrence of *Tritrichomonas muris* (Grassi) in native cricetid and heteromyid rodents of North America. In his review, he listed several species of cricetid rodents which served as hosts for this flagellate, but only one heteromyid. It seemed probable, therefore, that native cricetid rodents represented the normal host for *T. muris*. As a result of his investigations on intestinal flagellates of California rodents, however, Doran (1953) observed *T. muris* in 6 species of the family Heteromyidae and in 3 species of the family Cricetidae, thus establishing that *T. muris* might be as common in one group of rodents as in the other.

During the summers of 1953 and 1954, the writer examined caecal smears, both fresh and stained, from animals belonging to 17 species of rodents trapped in the Great Salt Lake Desert of Western Utah. Over 200 heteromyid rodents were examined, including *Dipodomys ordii pallidus, D. microps bonnevillei, Perognathus formosus incolatus, P. parvus olivaceus, P. longimembris gulosus* and *Microdipodops megacephalus leucotis*, but flagellates of the species *T. muris* were not found. Of the eight species of cricetid rodents studied, this flagellate was found in large numbers in 42% of *Peromyscus maniculatus sonoriensis* (133 animals examined), 12% of *P. crinitus pergracilis* (17 animals examined), 69% of *P. truei nevadensis* (16 animals examined), and in the single specimen of *Neotoma cinerea acraia*. *Tritrichomonas muris* was also found in the sciurid, *Citellus leucurus leucurus* (Evans, F. R., 1955, J. Protozool. **2** Suppl.: 1). Therefore, as concerns the desert rodents of western Utah, *T. muris* appears to be confined to cricetid rodents and to *Citellus leucurus*.—FREDERICK R. EVANS, *Department of Zoology, University of Utah, Salt Lake City.*

ENCEPHALITIS IN A SWAN DUE TO *DENDRITOBILHARZIA* SP. (TREMATODA; SCHISTOSOMATIDAE)

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On February 3, 1955 a 2-year-old swan (*Cygnus cygnus*) was submitted to the Diagnostic Service of the University of Illinois, College of Veterinary Medicine by the Illinois State Department of Conservation. It had been hatched on a private waterfowl farm at Mattoon, Illinois and had later been placed on a pond in Springfield, Illinois. It had been weak and partially paralyzed for several days previous to submission to the laboratory. It refused food, and exhibited nervous convulsions when excited. It died 4 days after submission.

Extreme emaciation and mild enteritis were observed at autopsy. Because of the encephalitic symptoms, a virus disease was suspected, and chick embryos were inoculated with brain tissue. The brain, duodenum, liver, pancreas, gizzard and proventriculus were fixed in Zenker's fluid, sectioned and stained with hematoxylin and eosin. A segment of small intestine was placed in the refrigerator.

No virus was found by embryo inoculation, but on examination of a section of the brain, an adult trematode was seen in a small artery in the meninges between the cerebral hemispheres (Figs. 1, 2), and numerous eggs were found in the cerebrum. The segment of small intestine had been in the refrigerator for several days, but it was now removed, and fragments of worms were teased out of the mesenteric blood vessels attached to it. They were identified as *Dendritobilharzia* sp., but they disintegrated before they could be studied further. One large segment closely resembled the anterior end of the male *D. pulverulenta* figured by Price (1929) after Skrjabin and Zakharow (1920), but it was not examined enough to determine whether it was actually this species or another member of the genus.

An effort was made to obtain other infected birds. A visit was made to the Mattoon farm where a number of different species of waterfowl, some of them exotic in origin, were being raised. Fecal samples taken from some of the birds were negative, and no infected snails were found either in the duck pond or in its runoff stream.

HISTOPATHOLOGY

Microscopic examination of the cerebrum revealed widespread distention of the capillaries by trematode eggs (Fig. 3). Some of the eggs were normal in structure, while others were degenerating and in some cases partially calcified (Fig. 4). The vessel walls adjacent to the degenerating eggs showed edema and moderate infiltration with mononuclear cells. Giant cells were present surrounding the degenerating eggs inside some of the vessels. Some of the capillaries in the cerebrum showed marked congestion as the result of obstruction by the fluke eggs.

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A cross section of an adult fluke was found in a small artery located in the meninges between the cerebral hemispheres. No evidence of inflammation was observed in the wall of this artery.

Numerous fluke eggs were found in the vessels of the liver. As in the brain, some of the eggs were normal, while others were in various stages of degeneration. The vessels walls containing normal eggs showed no evidence of inflammation, but moderate to marked infiltration with inflammatory cells was observed around the vessels containing degenerating eggs. The inflammatory cells were granulocytes and lymphocytes, with granulocytes in predominance. Giant cells were observed within the vessel walls surrounding some of the degenerating eggs.

Fluke eggs were also observed within the vessels of the pancreas, the villi of the duodenum and the submucosa of the gizzard. Only minor perivascular inflammatory changes were present in these tissues.

DISCUSSION

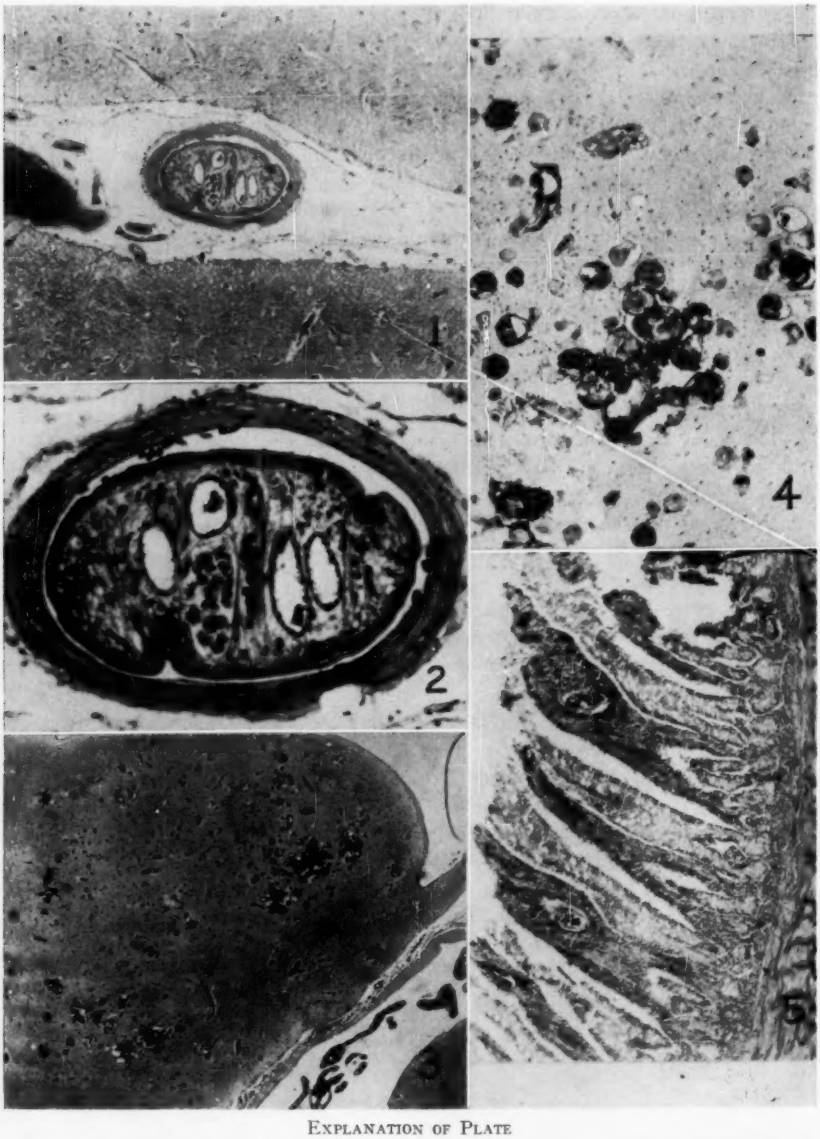
The genus *Dendritobilharzia* Skrjabin and Zakharow, 1920 can be differentiated from all other genera in the Schistosomatidae by its digestive tract. The intestine divides to form 2 cecal crura, but these soon rejoin to form a long common cecum which zigzags back to the posterior end of the body, giving off short, club-shaped or branched lateral ceca. In addition, *Dendritobilharzia* has no suckers and no gynecophoral canal.

Four species of *Dendritobilharzia* have been named. Since they have apparently not heretofore been compared with one another, the differentiating characters are given briefly below. Further study of all species, and particularly of *D. loossi* and *D. asiaticus,* is warranted.

The male of *D. pulverulenta* (Braun, 1901) Skrjabin, 1924 was first described as *Bilharziella pulverulenta* by Braun (1901, 1902) from the blood vessels of *Anas querquedula* from Dongola, Sudan. Odhner (1911) reported males in the mandarin duck, *Dendronessa galericulata* (= *Aix galericulata*), but did not describe them. Skrjabin and Zakharow (1920) described the male from the blood vessels of *Anas boschas* in the Don basin of Russia, and established the generic name *Dendritobilharzia* for it, naming the species *D. odhneri.* Later Skrjabin (1924) showed that *B. pulverulenta* and *D. odhneri* were the same, and on the basis of priority should be called *Dendritobilharzia pulverulenta.* Semenow (1927) described a female fluke from *Anas querquedula* which he assigned with a question mark to *D. odhneri,* but Ejsmont (1929) examined one of his preparations and found it to be *Bilharziella polonica.* Ejsmont (1929) found and described both a male and female *D. pulverulenta* in the blood vessels of an *Anas querquedula* in Poland.

The male of *D. pulverulenta* is 8.0 to 8.5 mm and the female 6.3 mm long. The genital pore of the male is 1.35 mm and that of the female 0.24 mm from the anterior end. Ejsmont (1929), the only person to describe the female, saw no eggs, and believed that this fluke lays them one at a time.

D. loossi Skrjabin, 1924 was described from a single female from a pelican, *Pelecanus onocrotalus,* in Russia. It was found in washing the small intestine, but apparently got into the intestine from the blood vessels. Skrjabin's (1924) description of it is sketchy and not accompanied by a figure. However, it differs



EXPLANATION OF PLATE

FIG. 1. *Dendritobilharzia* sp. in small artery in meninges between the cerebral hemispheres of a swan. Zenker's Hematoxylin and eosin. ×80.

FIG. 2. Enlargement of portion of Fig. 1. Note that the fluke intestine is sectioned in four places. ×230.

FIG. 3. *Dendritobilharzia* sp. eggs in swan cerebrum. Note congestion due to occlusion of capillaries by fluke eggs. Zenker's. Hematoxylin and eosin. ×19.

FIG. 4. Enlargement of portion of Fig. 3. The darker eggs are partially calcified. ×80.

FIG. 5. Two eggs of *Dendritobilharzia* sp. in capillaries of villi of swan duodenum. Zenker's. Hematoxylin and eosin. ×80.

from *D. pulverulenta* in size, being 14.2 mm long. Skrjabin said nothing about either uterus or eggs.

D. asiaticus Mehra, 1940 was described from a single female from a branch of the anterior mesenteric vein of a common teal, *Anas crecca crecca* (= *Nettion c. crecca*), in Allahabad, India. It is 6.0 mm long, with a terminal genital pore close to the right side of the mouth. The uterus is large, convoluted, and contains a large number of eggs which are nearly oval, with a fairly thick yellow-brown shell and a short, pointed spine at one end; they measure 27 to 33 by 15 to 18 microns, including the spine.

D. anatinarum Cheatum, 1941 was described from specimens in the dorsal aorta of 2 mallard ducks, *Anas platyrhynchos platyrhynchos,* in New York. Cheatum found the spherical eggs of this species in scrapings from the intestinal mucosa of these ducks and of 1 of 9 black ducks, *Anas rubripes,* and 1 of 6 canvas-back ducks, *Nyroca valisineria.* He also found unidentified spindle-shaped eggs containing miracidia in scrapings from the intestinal mucosa of these and 6 other species of wild ducks in New York. The male of *D. anatinarum* is 6.2 mm and the female 8.0 mm long. The genital pore of the male is 1.2 mm and that of the female 0.35 mm from the anterior end. The uterus is long, and contains numerous spherical eggs 60 to 65 microns in diameter. The eggs have no spine when laid.

Brackett (1940) reported that L. R. Penner had found *Dendritobilharzia* sp. in the white-winged scoter, *Melanitta fusca* (= *M. deglandi*), in Minnesota. Finally, Levine, Clark and Hanson (1955) reported *Dendritobilharzia* sp. in a swan in an abstract of the present paper.

Little is known of the pathogenicity of *Dendritobilharzia.* Cheatum (1941) noted enteritis in mallards infested with *D. anatinarum,* and considered that the eggs caused hyperemia, petechial hemorrhages and necrosis in working their way thru the muscularis, submucosa and intestinal mucosa. Encephalitis due to *Dendritobilharzia,* or for that matter to other avian schistosomes, has apparently not been previously reported.

SUMMARY

Dendritobilharzia sp. was found in a small artery in the brain and in the mesenteric blood vessels of an Illinois swan (*Cygnus cygnus*) which had died with symptoms of encephalitis. On histopathological examination, the cerebrum was found to contain many fluke eggs. Eggs were also found in the villi of the small intestine and in the liver, pancreas and gizzard submucosa.

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RESEARCH NOTE

SOME HELMINTHS OF MAMMALS FROM ST. LAWRENCE ISLAND, ALASKA, WITH A DISCUSSION ON THE NOMENCLATURE OF *ECHINOCOCCUS* IN VOLES

Few mammals are indigenous to St. Lawrence Island, although others may occasionally reach it via ice bridges or floes. During the summers of 1954 and 1955, helminthological investigations were undertaken on the island. From the mammals examined, 7 genera of helminths comprising about 8 species were recovered. These parasites are as follows: *Ascaris laevis* Leidy, 1856, and *Taenia* sp., from the ground squirrel (*Citellus undulatus*); *Heligmosomum* sp., from tundra mice (*Microtus occonomus* and *Clethrionomys rutilus*); *Paranoplocephala infrequens* (Douthitt, 1915), from the tundra vole (*Microtus oeconomus*); *Uncinaria stenocephala* (Railliet, 1885), *Toxascaris leonina* (Von Linstow, 1902), and *Taenia pisiformis* (Block, 1780), from the arctic fox (*Alopex lagopus*). *Echinococcus* sp., also collected from the above named hosts and the tundra shrew (*Sorex jacksoni*), was reported by Thomas *et al.* (1954, Sc. **120:** 1102–1103).

The nomenclature of *Echinococcus* in voles occurring on St. Lawrence and Bering Islands is controversial. The parasite was reported as *"Taenia echynococcus"* from *Clethrionomys rutilus* by Barabash-Nikiforov (1938; Jour. Mammal. **19:** 423–429), as *E. granulosus* by Afana'sev (1941; Uchenie Zapiski, Seriia biolog. Nauk. **18:** 93–117) and Rausch and Schiller (1951; Sc. **113:** 57–58), and as *Echinococcus* sp. by Rausch in several later publications. Because of "1) the natural occurrence of the larval stage in microtine rodents; 2) and alveolar-form larva which is produced through exogenous budding," Rausch and Schiller (1954; J. Parasitol. **40:** 659–662) described the cestode as *"Echinococcus sibiricensis* n. sp."

Echinococcus spp. reported in rodents from islands in the Bering Sea are believed by the present writers to be cospecific with a known species occurring in humans of Eurasia. The intermittent reports for over 50 years of a form of echinococcosis with exogenous budding are reviewed by Dew (1926; Med. J. Austral. **2:** 301–309). Attempts to find records, in the literature, of experimentally infected rodents with the proliferative type of echinococcosis have been unsuccessful, although natural and experimental infection of rodents with *E. granulosus* are reported: Llanos (1953; Archiv. Intenat'l. Hidatidosis **13:** 278–279) cites its occurrence in *Sciurus vulgaris* and *Lepus* sp.; Spasskii *et al.* (1951; Akad. Nauk. SSSR **5:** 42–52) record *E. granulosus* from *Ondata zibethica;* Baer, cited by Rausch (1953; Thapar Commem. Vol., Univ. Lucknow, India, pp. 233–246), obtained an infected vole with the larval stage of *Echinococcus* sp. E. Eagle. Inst. Vet. Med., Santiago, Chile, states (personal correspondence), "Experimentalmente se han infestado ratas y lauchas del laboratorio y actualmente estamos trabajando en la infestación con Echinococcus de un ratón de campo, el *Octodon degus,* hemos obtenido el desarrollo del quiste hidatidico; han apredo quistes aislado, uniloculares, de mas o menos un cm. en diámetro, pero no se ha desarrollado la forma alveolar."

On the basis of similar morphogenesis and pathogenesis, the writers are convinced that the form of echinococcosis reported from St. Lawrence Island mammals is specifically identical with the alveolar type existing in Eurasia. It may be determined that the forms of hydatid disease referred to as "multilocular" and "alveolar" are produced by the same parasite species, since it is conceivable that morphologically identical helminths could produce different pathological lesions in a given host species. Our contention is that the cestode designated as *Echinococcus sibiricensis* is not new, and it is recommended that this name be considered invalid. —LYELL J. THOMAS AND BERT B. BABERO, *University of Illinois Zoology Laboratory and the Arctic Aeromedical Laboratory.*

THE STIMULATION OF ACQUIRED IMMUNITY IN DOGS BY INJECTIONS OF EXTRACTS OF THE ESOPHAGUS OF ADULT HOOKWORMS*

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Experimental evidence for the enzyme-antienzyme hypothesis as an explanation for the mechanism of immunity to helminth infections (Chandler, 1932; Thorson, 1953) is sparse. It has been shown that serum from a dog refractory to infection with *Ancylostoma caninum* will inhibit proteolytic activity which is present in saline extracts of the esophagus of adult hookworms (Thorson, 1956). The experiment reported here was designed to determine whether dogs injected with these esophageal extracts which show proteolytic activity would produce antibodies which would inhibit the development and/or persistence of worms of a challenge infection.

MATERIALS AND METHODS

Adults of *Ancylostoma caninum* were recovered from dogs at autopsy and carefully washed in physiological saline. The esophagi were dissected from the worms and ground in a small volume of saline with a tissue grinder. The preparations were allowed to extract for varying periods of time at 5° C and were then centrifuged to remove the cellular debris. Using ultramicro-analytical methods, a sample of the supernatant was assayed for proteolytic activity and protein nitrogen. Since it was impossible to obtain and dissect at one time enough hookworms for the entire series of injections, the supernatants of several days' dissections were pooled and frozen. Before use as an antigen for injection, the preparations were thawed and again checked for enzymatic activity and nitrogen to determine if the solutions were essentially unchanged. In no instance was there a significant decrease or increase in these properties of the solution.

One ml of this solution represented the extraction of approximately 200 esophagi in physiological saline. There were 80 micrograms of protein nitrogen in each ml and one microgram of this nitrogen could produce 20 microliters of 0.02 N amino acids in a 2-hour reaction period using a microliter modification of Sorensen's formol titration with casein as the substrate (Thorson, 1956).

A litter of 7 dogs, 1 month old, was used in the experiment. Ascarids which were present in all the puppies were removed by anthelmintic treatment before the experiment was started. Four dogs, selected at random from the litter, received subcutaneous injections of the extractions of the esophagi described in the preceding paragraph. The schedule of injections for the dogs in the experimental group was

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0.2 ml on the first and third days, 0.4 ml on the fifth and eighth days, and 0.8 ml on the tenth, twelfth, and fifteenth days, for a total of 3.6 ml of esophagus extract.

On the nineteenth day of the experiment all of the dogs (those injected with extract and the uninjected controls) were infected subcutaneously with 250 infective larvae of *A. caninum*. The number of worms given was ascertained by direct count with care to insure that none of the larvae were lost in the process of infection.

Fecal examinations by modifications of the Lane and Stoll techniques were started 12 days after infection and were performed each day until the dogs were autopsied 20 days after infection. The entire intestine was removed and examined for worms. Each hookworm was counted and measured by placing a millimeter ruler on the stage of a dissecting microscope in a small pool of saline. The worms straightened out along the edge of the rule, and measurements were made quite easily. Only live worms were measured.

EXPERIMENTAL RESULTS

It was suspected that the injection of substances with enzymatic activity into dogs would stimulate the formation of antibodies which would act as antienzymes. Since these might hinder the development and persistence of at least the adult worms of a challenge infection, 3 criteria, egg productivity, number of worms in intestine, and size of worms, were used to determine if this had happened.

The total fecal output of the dogs did not differ significantly in quality or quantity, so an egg-per-gram count was used to determine if there were any difference in egg production of worms in dogs receiving injections and those not receiving injections. There was no difference in the number of eggs produced by the female worms in the 2 groups of dogs. This was interpreted as indicating that, at least in this stage of the infection, antibodies to substances in extracts of the esophagus of adults had no effect on the egg production of the female worms of a challenge infection.

The results of the determination of numbers of worms in the intestine are summarized in Table I. It can be seen that there was some reduction in the worm burden of dogs receiving injections of extracts of the esophagus of adult hookworms when compared to the number of worms in dogs receiving no injections.

TABLE I. *The numbers of adults of* Ancylostoma caninum *and the length of these worms of a challenge infection* recovered from dogs infected with extracts of the esophagus of adult hookworms as compared to those in uninjected dogs.*

	Injected Dogs		Uninjected Dogs
Numbers of worms	112 103 143 148		168 179 158
Mean (S.E.m) p**	126(± 12.7)	<0.05	168(± 7.5)
Number of female worms measured	231		196
Mean length in mm (S.E.m)	9.303 (0.053)		9.806 (0.065)
p		<0.01	
Number of male worms measured	191		217
Mean length in mm (S.E.m)	7.327 (0.038)		7.604 (0.049)
p		<0.01	

* 250 infective larvae of *A. caninum* administered subcutaneously.
** Student's "t" test.

When the worms from the 2 groups were measured, an additional effect of the injections of esophageal extracts on a challenge infection was observed (Table I). Statistical analysis allowed the lumping of the worms from separate dogs within the experimental group and within the control group. The worms in the dogs of the experimental group were significantly smaller than those in the control group, indicating that the injection of extracts of the esophagus from adult worms into dogs had a deleterious effect on the growth of worms of a challenge infection.

DISCUSSION

It has been shown that serum from a dog refractory to further infection with *Ancylostoma caninum* inhibits the proteolytic activity in extracts of the esophagus of adults of this worm (Thorson, 1956). It was desirable, therefore, to determine if injections of these esophageal extracts into dogs would cause the formation of antibodies to this substance which by inhibition of the proteolytic activity in the esophagus of worms would cause some interference with the development of a challenge infection. The experiment described above gives some evidence that this is the case, since there were fewer and smaller worms in the injected dogs as compared with the uninjected dogs.

There was no inhibition of the egg production of the female worms in the injected group of dogs when compared with that of the uninjected group, but it must be remembered that if the experiment had been allowed to continue for a longer period, such an effect might have been observed. This phenomenon has been very well demonstrated by Campbell (1955) in his work with the secretions and excretions of *Trichinella spiralis* as antigens in the development of protective immunity. He found that a deleterious effect on the reproductive potential of female worms could be shown only if the experiment were allowed to continue for longer periods than usual for this type of experiment.

The fact that there were fewer and smaller worms in the dogs injected with esophageal extracts than in those receiving no injections may be ascribed to the fact that antibodies were formed in the injected dogs against the enzyme(s) in these extracts. These antibodies inhibited the action of the enzymes of the esophagus of the worms of a challenge infection to the extent that the worms were not able to grow to their full size and were not able to persist in the unfavorable environment. It has been suggested that the proteolytic activity in the extracts may be concerned with extracorporeal digestion (Thorson, 1956) and the inhibition of this enzyme by antibodies acting as antienzymes might well prevent the worms from feeding properly.

Although only proteolytic activity was measured in the extracts, it is well to remember that there may be other enzymes present. Preliminary work indicates that these extracts also possess lipolytic activity. Therefore, the differences that occurred in the worms in the injected dogs must not be considered as due only to antibodies formed to proteolytic enzymes.

If the actual mechanism of immunity to helminth infections is considered, this experiment gives additional evidence for the hypothesis that antibodies which may act as antienzymes are formed in hosts to substances which possess enzymatic activity in the secretions and excretions of worms, and that these enzymes in worms of a subsequent infection are inhibited, resulting in poor growth and persistence of these worms in the host (Chandler, 1932; Thorson, 1953, 1956).

SUMMARY

Physiological saline extracts of the esophagi of adults of *Ancylostoma caninum* which contain substances with proteolytic activity were injected into dogs. The hookworms of a challenge infection were fewer in number and smaller in these dogs than those in dogs which had received no injections of esophageal extracts.

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RESEARCH NOTE

OVICIDAL ACTIVITY OF CERTAIN COMPOUNDS ON THE EMBRYONATED EGGS OF *ASCARIS LUMBRICOIDES*

Molluscicides are often applied to soil and their effect on the macroscopic fauna has been observed. These chemicals also come into contact with the eggs and larvae of helminths which have developmental stages in the soil. Since the eggs of *Ascaris lumbricoides* may be the most resistant of these stages, they were selected for the screening of 458 chemicals that had been tested as molluscicides (McMullen, 1952, Am. J. Hyg., **1:** 671–679). For various reasons this work will not be continued. It was felt that the data obtained should be made available to others.

In order to incubate eggs to the vermiform stage, the following modification of a technic devised by Captain B. C. Walton was used. Female worms were examined and those with infertile eggs were discarded. The terminal centimeter of the uterus of worms with fertile eggs was stripped into a large Petri dish about one-third filled with saline. After about 50 worms had been stripped, the egg-saline suspension was uniformly mixed and a drop placed on the center of a clean slide. When the drop was spread out the slide could be inverted without the fluid running off. In this inverted position the slides were placed in wooden slide boxes previously saturated with 10 per cent formalin. The boxes were placed in mouse jars which were kept moist with large pads of cotton saturated with 10 per cent formalin. A glass plate on top of the jar prevented evaporation. After 11 to 12 days at room temperature, the eggs had reached the vermiform stage and 3 drops of a known dilution of test chemical were applied with a standard eye dropper. The chemical was then permitted to dry at room temperature. Pure solvents were placed on the control slides in like manner. The test and control slides were then returned to the humid chamber.

The eggs were examined 22 to 34 days later. The presence of large globular masses within the larvae coupled with the absence of motility were the criteria of death.

In repeated tests 4-thiocyano-o-cresol, 4-thiocyano-m-cresol, 4-thiocyano-o-ethylphenol, 4-thiocyano-2,6-xylenol, 4-thiocyano-3,5-xylenol, and acridine, at dilutions of 1:10,000, killed 80% or more of the larvae. Single trials on copper acetonyl acetone, methallyl chloride, dio-o-tolyl thiourea, and cincophane, gave similar results at the same concentration. Single tests, using higher dilutions of the 4-thiocyano- compounds gave results that were irregular. 4-Thiocyano-o-cresol at 1:100,000 killed 73 per cent of the larvae but at 1:200,000 it had no effect. The results obtained from single tests should not be considered as proof of ovicidal activity. It is of interest that all of the 4-thiocyano- compounds tested were toxic at high dilutions.—DALE E. WYKOFF AND STUART A. ALTMANN, *Department of Medical Zoology, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington 12, D. C.*

CURRENT STATUS OF INTESTINAL PARASITISM OF MAN IN EASTERN KENTUCKY[1]

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Studies concerned with the prevalence of intestinal parasites, especially helminths, have been conducted previously in the region of the Cumberland Plateau. It has been observed that several species of worms occurred at a relatively high rate among the inhabitants in the mountainous area of eastern Kentucky. As early as 1910, the U. S. Army recognized that a significant proportion of recruits from Kentucky harbored hookworm (Teague, 1945). Subsequent investigations sponsored by the Rockefeller Foundation during 1912–14 were directed toward this problem. Later reports by Otto and Cort (1934), as well as Keller and Leathers (1936), also called attention to the frequency with which *Ascaris lumbricoides, Trichuris trichiura,* and certain other intestinal helminths were observed among the inhabitants of the region. In summarizing the situation, Teague (1945) estimated that one-fifth of the population of Kentucky, some 600,000 individuals, were burdened with one or more species of intestinal parasites. The present investigation was conducted during 1955, in Floyd and Letcher Counties, Kentucky, as a part of studies relative to enteric disease and its control.

MATERIALS AND METHODS

Single fecal samples were collected in half-pint cardboard cartons from homes in the study areas. Specimens were routinely brought into the laboratory in less than 24 hours after collection and refrigerated until examined microscopically. Under the circumstances, it was impractical to include protozoan trophozoites in the study due to their rapid disintegration and it is well known that stool examinations are inadequate for the detection of *Enterobius vermicularis.* Cysts of protozoa, eggs and other stages of helminths were thus the objects of the laboratory examinations during the investigation. In the earlier phase of the study, stool specimens were examined by direct smear in normal saline, and in Dobell's iodine solution, when desirable, as an aid in identifying cysts. Smears during this period were also observed following concentration by the method of formalin-ether sedimentation (Mackie *et al,* 1954). In addition, counts of helminth eggs were made by the Beaver direct smear method described in the same reference. Examinations were restricted to egg counts in the later phase of this investigation. A total of 10 areas was included in the studies; 9 of these areas were mining camps and the other was characterized as a rural hamlet.

RESULTS

Prevalence of intestinal parasites during January–March, 1955, are presented in Table I and are based on examinations of single stools in 8 study areas. Approxi-

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Table I. Prevalence of intestinal parasites by age among individuals in 8 study areas in Eastern Kentucky; January-March, 1955

Parasites	All Ages 843 Spec.		0–4 Yrs. 298 Spec.		5–9 Yrs. 280 Spec.		10–14 Yrs. 94 Spec.		15+ Yrs. 171 Spec.	
	No. Pos.	% Pos.	No. Pos.	% Pos.	No. Pos.	% Pos.	No. Pos.	% Pos.	No. Pos.	% Pos.
Entamoeba histolytica	28	3.3	2	0.7	12	4.3	7	7.4	7	4.1
Entamoeba coli	177	21.0	24	8.1	65	23.2	37	39.4	51	29.8
Endolimax nana	50	5.9	2	0.7	13	4.6	18	19.1	17	9.9
Iodamoeba butschlii	5	0.6	-	-	-	-	2	2.1	3	1.8
Giardia lamblia	80	9.5	35	11.7	27	9.6	9	9.6	9	5.3
Chilomastix mesnili	4	0.5	1	0.3	2	0.7	1	1.1	-	-
Ascaris lumbricoides	226	26.8	85	28.5	109	38.9	23	24.5	9	5.3
Trichuris trichiura	204	24.2	58	19.5	108	38.6	27	28.7	11	6.4
Hookworm	-	-	-	-	-	-	-	-	-	-
Strongyloides stercoralis	10	1.2	1	0.3	3	1.1	1	1.1	5	2.9
Enterobius vermicularis	6	0.7	-	-	4	1.4	1	1.1	1	0.6
Hymenolepis nana	11	1.3	1	0.3	9	3.2	1	1.1	-	-
Individuals with 1 or more parasites	471	55.9	128	43.0	201	71.8	64	68.1	78	45.6
Individuals with no parasites	372	44.1	170	57.0	79	28.2	30	31.9	93	54.5

mately two-thirds of the 843 specimens examined for both intestinal protozoa and helminths were collected from children less than 10 years old. Findings with regard to occurrences of the more important species showed *Entamoeba histolytica* in 3.3% of the fecal samples observed. *Ascaris lumbricoides* was observed in nearly 27%, *Trichuris trichiura* in approximately one-fourth of the specimens, and *Strongyloides stercoralis* in slightly more than 1%. *Hymenolepis nana* was also noted at a rate similar to that of *Strongyloides*, but no evidence of hookworm was detected in this series of examinations. Protozoa were observed most frequently in the 10- to 14-year age group, while the helminths occurred more commonly among those of 5 to 9 years. Virtually no difference was perceptible in the percentages of individuals in the 5- to 9-year and 10- to 14-year groups relative to the presence of 1 or more species of parasites. Approximately 56% of the total 843 individuals in this series harbored at least 1 type of parasitic organism in the intestine.

Attention in the laboratory was subsequently directed solely to the helminths during April–July, 1955. Table II shows the results in different age groups with

Table II. Distribution of most common helminths by age groups; 10 study areas April-July 1955

Helminths	All Ages 1800 Total Indiv.		0–4 Yrs. 397 Total Indiv.		5–9 Yrs. 456 Total Indiv.		10–14 Yrs. 286 Total Indiv.		15+ Yrs. 661 Total Indiv.	
	No. Pos.	Percent of total	No. Pos.	Percent of total	No. Pos.	Percent of total	No. Pos.	Percent of total	No. Pos.	Percent of total
Ascaris lumbricoides	384	21.3	109	27.5	167	36.6	62	21.7	46	7.0
Trichuris trichiura	263	14.6	50	12.6	128	28.1	55	19.2	30	4.5
Strongyloides stercoralis	47	2.6	1	0.3	10	2.2	11	3.8	25	3.8
Hymenolepis nana	26	1.4	3	0.8	15	3.3	4	1.4	4	0.6
Hookworm	9	0.5	-	-	1	0.2	3	1.0	5	0.8

respect to the intestinal worms most commonly observed in this later series of examinations of single stools in a total of 10 study areas. There were 2 areas

added to the 8 included in the previous and more detailed observations (Table I). The over-all rates of prevalence varied somewhat from those disclosed by the earlier observations, but among children less than 10 years of age, the rates of roundworm were very similar. More than one-third of the 1800 individuals examined in the total shown in Table II were over 15 years old, while only one-fifth of those observed in the previous study were in this age group. Prevalence rates for all the helminths noted were relatively low in this oldest category. *A. lumbricoides* was found in approximately 1 of every 3 children under 10 years that were observed in both series of examinations. Results presented in Table II also indicate *S. stercoralis* in 2.6% and hookworm in 0.5% of the total individuals included in this later study.

Data from the 1800 examinations of reference in the previous table are presented according to study areas in Table III. This reveals differences in total prevalence of intestinal helminths among the various areas. In the area with the greatest prevalence, there was a rate of 45% in the age group above 15 years which was nearly twice the highest rate for that group in other areas. The poorest settlements generally reflected the highest rates given in Table III and the lowest prevalence shown was observed in an extraordinarily modern mining camp.

Table III. Individuals parasitized by one or more intestinal helminths:

By age groups 10 study areas, Eastern Kentucky; April-July 1955

Study area ranked by prevalence rate / Study area	Total			0-4 Years			5-9 Years			10-14 Years			15+ Years		
	Total	No. Pos.	% Pos.	Total	No. Pos.	% Pos.	Total	No. Pos.	% Pos.	Total	No. Pos.	% Pos.	Total	No. Pos.	% Pos.
Jacks Creek	205	120	59	41	19	46	57	48	84	38	22	58	69	31	45
Manton	53	26	49	15	6	40	19	14	74	7	3	43	12	3	25
Weeksbury	176	88	50	52	31	60	46	30	65	29	19	66	49	8	16
Wayland Hollow	164	75	46	38	19	50	40	31	78	30	15	50	56	10	18
Wheelwright Hollow	100	44	44	17	11	65	25	19	76	14	8	57	44	6	14
Drift	180	59	33	49	21	43	49	24	51	27	5	19	55	9	16
Hemphill	160	52	32	31	9	29	39	27	69	30	9	30	60	7	12
Wayland	127	21	17	23	2	9	23	7	30	24	4	17	57	8	14
Auxier	75	12	16	14	4	29	20	6	30	10	2	20	31	0	0
Wheelwright	560	61	11	117	12	10	137	27	20	77	15	19	229	7	3
Total	1800	558	31	397	134	34	455	233	51	286	102	36	662	89	13

Relative intensities of infections of *A. lumbricoides* and *T. trichiura* according to egg counts are given in Table IV. Numbers of individuals observed with ascarid egg counts greater than 50 per mg of feces varied from 0 in 2 study areas to 20% of the total infected in another community. Of the 384 persons positive in all areas, 6% were found to have these heavy infections of *Ascaris*. Only a single individual of the 263 with Trichuris was observed to have a trichurid egg count greater than 10 per mg.

DISCUSSION

An extremely low prevalence of hookworm such as that noted during 1955 in the populations studied was rather unexpected. Among earlier observations, the report of the Rockefeller Foundation (Teague, 1945) stated that 37% of 79,000 individuals examined in Kentucky during 1912–14 were positive. The highest rates occurred in the eastern part of the State. In this region, it appeared,

Table IV. Heavy infections of Ascaris and Trichuris; 10 study areas

Eastern Kentucky, April–July 1955

Study area	Total No. spec.	Number spec. positive for Ascaris	No. Ascaris egg counts 50+ per mg.	Percent	No. spec. positive for Trichuris	No. Trichuris egg counts 10+ per mg.	Percent
Auxier	75	10	2	20.0	3	0	-
Wheelwright	560	35	1	2.9	33	0	-
Wheelwright Hollow	100	28	1	3.6	35	0	-
Neeksbury	176	59	2	3.4	40	0	-
Wayland	127	6	0	-	8	0	-
Wayland Hollow	164	63	8	12.7	23	0	-
Manton	53	14	0	-	17	0	-
Drift	180	43	2	4.7	20	0	-
Jacks Creek	205	90	5	5.6	59	1	1.7
Hemphill	160	36	2	5.6	25	0	-
Total	1800	384	23	6.0	263	1	0.4

according to information compiled by Otto in 1936 from several thousand examinations during 1930, that some decline had taken place. Keller, Leathers, and Jensen (1936) found 8.5% of approximately 24,000 individuals examined in 1934–35 infected with hookworm in the area. A great decrease in prevalence since 1914 therefore seemed evident. However, Teague (1945) reported that 30 per cent of some 7,500 fecal samples submitted to the laboratory of the State health department during 1940–44 were found to contain hookworm.

Observations reported for the present investigation showed *Ascaris* prevalent in nearly 30% of the individuals studied. Otto and Cort (1934) had noted over 40% of more than 52,000 persons in the mountainous areas of Kentucky to be infected with this parasite. Earlier studies referred to by the same authors gave a prevalence slightly above 30% for the State. *A. lumbricoides* was noted in over one-third of approximately 24,000 individuals examined by Keller and Leathers (1936). Of the 7,500 stool samples (1940–44) mentioned by Teague (1945), 46% showed evidence of roundworm. The impression is that the prevalence of *Ascaris* has not changed significantly over the years.

Considerable variation is apparent in the literature regarding the prevalence of *Trichuris trichiura* in Kentucky. Otto (1932) stated that distribution of *Trichuris* paralleled that of *Ascaris*, although *Trichuris* was not found as uniformly as *Ascaris* due to additional moisture being necessary for trichurid egg development. Keller and Leathers (1936) reported 10%, whereas Cort and Otto (1937) had found as high as 40% among some groups of children studied in the eastern Kentucky mountains. Teague (1945) gave a rate of 16% for whipworm. Observations in the current study appear to represent comparable levels of occurrence for this species.

Because strongyloidiasis is self-perpetuating and becomes a serious condition when hyperinfection takes place, occurrences of *S. stercoralis* are noteworthy. Prevalence of this helminth was found in general to be low (1.8 per cent) in this study. However, it is felt that a specific study of the prevalence of this parasite would disclose many more cases.

Of the other parasites encountered, *Entamoeba histolytica* was observed in relatively few individuals and reports of physicians in the region usually attached little importance to amebiasis.

SUMMARY AND CONCLUSIONS

Prevalences of human intestinal parasites were observed during 1955 in 10 areas in the eastern Kentucky mountains. More than half of 843 individuals who submitted fecal specimens early in 1955 harbored at least one species of protozoan or helminth. An additional 1800 examinations for the presence of intestinal helminths only were conducted later that year. According to the findings of the entire investigation, *A. lumbricoides* was the most prevalent form, since approximately 1 of every 3 children under 10 years was infected at the time of examination. Results also indicated *T. trichiura* and *S. stercoralis* to be of importance, but very few instances of hookworm infection were noted in populations studied. Six per cent of the ascarid-burdened individuals had egg counts greater than 50 per mg of feces and were considered heavily infected. Practically all the counts of trichurid eggs were low. Additional intestinal parasites observed included *E. histolytica* which was noted in less than 4% of the persons examined, a large number of whom were younger children.

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ANNOUNCEMENT

NEW PROCEDURE FOR SMALL PUBLIC HEALTH SERVICE GRANTS

The Public Health Service has announced a new procedure to expedite the processing of research grant applications for those requests which do not exceed $2000 plus indirect costs and which do not ask support for more than one year. Such applications will be accepted and processed on receipt and are not therefore subject to the usual deadlines for submission prior to review.

Council recommendations can be expected on these applications within 1–4 months from the time of submission. These procedures do not apply for requests for supplements to existing grants.

Address all applications as well as requests for forms or additional information to the Division of Research Grants, National Institutes of Health, Bethesda 14, Maryland.

A DIOECIOUS SPECIES OF *GYROCOELIA* (*CESTODA: ACOLEIDAE*) FROM THE NAPED PLOVER

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INTRODUCTION

Among cestodes collected from shore birds of Puerto Rico in 1951–52 was a dioecious species of the genus *Gyrocoelia* found in the naped plover (*Pagolla wilsonia rufinucha*). Although the cestode is different from species that have been well described, its final identification is made impossible by the inadequacy of the description and type material of *Gyrocoelia milligani* which Linton (1927) described from a sanderling (*Crocethia alba*) collected on the North Carolina coast. Cestodes identified as *G. milligani* were later reported from a killdeer (*Oxyechus vociferus*) in Antigua by Baer (1940) and from the snowy plover (*Charadrius nivosus*) on the Gulf coast of Texas by Webster (1951). Earlier, however, Webster (1943) had re-examined Linton's slide of type material and reported that species of 2 genera, *Gyrocoelia* and *Progynotaenia*, had been confused. Webster accordingly restricted original type material of *G. milligani* on Linton's slide to 2 adjacent pieces of strobila, both female in content, and accepted Baer's description as the first revision of the species.

Two specimens, a male and a female strobila, from the material described by Webster (1951) have been obtained from him, and Mr. Allen McIntosh has kindly provided Linton's original slide of *Gyrocoelia milligani* for study. In the latter, the youngest proglottids of the 2 pieces mentioned above are 1.27 mm wide, show the female complex well developed, and hence could have been preceded by a region of the strobila in which testes were present as in at least some of Baer's (1940) specimens or could have come from an entirely female strobila as in Webster's material and that reported here. The oldest proglottids in Linton's slide show some distension and outpocketing of the uterus but are not sufficiently advanced to show fully formed eggs with hexacanth embryos which would provide significant and reliable taxonomic characters. Even if the portion of Linton's material interpreted by Webster (1943) as an entire specimen belonging to another genus were actually a part of *G. milligani*, the important rostellar hooks are missing and the specimen is otherwise in such poor condition as to be of little value as type material. Thus it is evident that additional specimens of *G. milligani* must be obtained from the type host to make a valid comparison of any material with that species. Nothing is known concerning host specificity of these cestodes; it may be that material mentioned thus far, obtained from 4 distinct host species, represents as many species of *Gyrocoelia*. Certainly at least 2 species are involved, that described by Baer (1940) and the present one. At this time, the identification of either of these cestodes as *G. milligani* must be a tentative one and for that reason it seems as

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* Fellow, John Simon Guggenheim Memorial Foundation during 1951–52 when material reported in this paper was collected. Thanks are due to Mr. Felix Inigo and Dr. V. Biaggi for assistance in the collection and identification of birds and to the College of Agriculture and Mechanic Arts, Mayaguez, Puerto Rico, for laboratory facilities.

desirable to give an adequate description of our material provisionally under a new name and deposit recognizable type specimens as it would be to identify our species tentatively as *G. milligani* and rename the one reported by Baer.

OBSERVATIONS

The following description is based on 7 specimens, 2 from each of 2 birds and 3 from another. Two additional plovers were negative for the parasite. Five cestodes were complete with the scolex and in 2 that were not, most of each strobila was obtained. The worms were still alive when removed from the birds and yielded superior preparations. Totomounts were stained with Harris' hematoxylin and sections with hematoxylin and eosin. Clearing caused almost all eggs in gravid proglottids to collapse but a few remained in excellent condition.

All drawings except Fig. 9 were made by microprojection and all measurements are in millimeters.

Gyrocoelia pagollae sp. nov. provis. (Figs. 1–9)

Diagnosis: With characters of genus. Functionally dioecious with no evidence of testes in female strobila although cirrus sac is well developed and ultimately attains a size exceeding that in male; no indication of female organs in male strobila. Scolex (Fig. 1) 0.23–0.34 in diameter, suckers shallow, 0.114–0.146 in diameter. Rostellum protrusible, pestle-shaped, and when fully protruded, about 0.14 long, 0.063–0.067 wide near tip and 0.045 wide at base. Rostellar sac about 0.1 long and 0.08 in maximum width. Neck extremely short. Proglottids strongly craspedote, wider than long and very muscular. Longitudinal muscles in 4 layers here numbered from surface of strobila inward (Fig. 8): 1st imediately beneath cuticle; 2nd scattered through cortical parenchyma; 3rd and 4th best developed and most sharply defined, 3rd with 90–124 bundles, 4th with 62–72. Transverse muscles weakly developed, in 3 layers situated outside 3rd, between 3rd and 4th, and inside 4th longitudinal muscle layers. Dorsoventral muscles extend as wavy strands through medullary parenchyma only. Genital pores alternating regularly in male and irregularly to a slight extent in female and then with never more than 2 adjoining proglottids with pores on same side; pore at middle of proglottid edge, on a papilla prominent in male, but in proglottids of female only after uterus begins to fill with eggs. Cirrus sac massive, passing between excretory ducts on poral side, never reaching ducts on aporal side. In proglottids comparable in size, dimensions and shape of cirrus sac and thickness of its outer layer of oblique muscles vary with extent to which cirrus protrudes; with cirrus fully everted, sac is smallest and muscle layer thickest, but never exceeding 0.022. Cirrus heavily armed with spines which seem to be slightly finer and more numerous on side toward velum of proglottid.

Male. Strobila about 30.0 long with proglottids attaining maximum length of 0.560 and width of 0.970. Primordium of cirrus sac visible by about 11th segment from scolex, testes as tiny cluster in the 21st. Cirrus sac to 0.520 long and 0.150 wide; well developed extrinsic muscles evidently protract sac and thus evert genital atrium to greatly increase length of genital papilla; eversion of cirrus independent of sac position, however (cf. Figs. 3, 4). Numerous small prostatic cells with fine ducts join sperm passage which enlarges to form a vesicle, then narrows to a convoluted tube swollen with sperms before emerging from cirrus sac and extending posteriorly to collect sperms from testes. Testes 20–30, in a compact, often somewhat triangular mass in center of proglottid, becoming exhausted and disappearing in old proglottids.

Female. Strobila to about 75.0 long; gravid proglottids attain a length of 0.8 and width of 2.9. Cirrus sac to 0.765 long and 0.207 wide; its structure and appearance as in male except that passage apparently contains no sperms; genital atrium and papilla less conspicuous than in male; cirrus everted only in gravid segments; vagina absent. Reproductive complex in center of proglottid; ovary extensively lobed, fan-shaped, and occupying 40–45% of proglottid width in moderately extended segments from time ovary appears until it attains maximum development. Vitelline gland median, near posterior edge of proglottid, transversely elongated, finely lobed and slightly constricted or widely V-shaped; shell gland median, between vitelline gland and ovary; a convoluted uterine duct extends anteriorly from shell gland to join uterus. Uterus dorsal to ovary and vitelline gland, appearing with ovary in young proglottids as a transversely oval strand encompassing an area smaller than that occupied by female glands. With further development, uterus becomes tubular (Fig. 5) and on filling with eggs, further elongates tranversely as diverticula appear (Figs. 6, 7), those joining anterior half of ring becoming espe-

cially voluminous. Posteriorly, a median prolongation of uterus seemingly extends into next proglottid but actually opens at a dorsal and a ventral pore beneath edge of velum. A pair of deeply staining structures which flank shell gland may be a seminal receptacle but does not appear until proglottid is in late maturity. Eggs (Fig. 9) thin-shelled, oval, with somewhat pointed ends, 0.059–0.068 long and 0.032–0.036 wide when not collapsed; embryophore lemon-shaped, with maximum size of 0.040 by 0.030; hexacanth larva a maximum of 0.032 by 0.029 in stained whole mounts; embryonal hooks 0.012–0.014 long. A thick, gelatinous layer between shell and embryophore is indicated by lines of shrinkage from shell, especially at ends.

Host: the naped plover, *Pagolla wilsonia rufinucha.*

Locality: Cabo Rojo, Puerto Rico.

Type specimens: female (Holotype on 2 slides, paratypes as gravid proglottids, entire and sectioned on 2 slides) No. 49499 and male (allotype) No. 49500, Helminthological Collection U. S. National Museum.

DISCUSSION

Differentiation of species of *Gyrocoelia* is complicated by inadequate descriptions of some species and disagreements in the existing accounts of others. The important scolex armature is unknown for type material of 3 species: *G. perversa* Fuhrmann, 1899, the type species in which the rostellar hooks evidently were lost; *G. australiensis* Johnston, 1910, the entire scolex of which is unknown; and *G. milligani,* Linton, 1927, the type material of which includes the scolex of a species of *Progynotaenia* instead of *Gyrocoelia,* according to Webster (1943). If the material later described by Baer (1940) as *G. milligani* actually is that species, as is assumed for the present, then *G. milligani* has 40 rostellar hooks whereas *G. pagollae* has 66. Of other species for which the number of rostellar hooks is known, *G. crassa* Fuhrmann, 1900, (synonyms: *G. brevis* and *G. leuce,* according to Baer, 1940) has 40; *G. paradoxa* von Linstow, 1906, has 78; *G. kiewietti* Ortlepp, 1937, has 84; and only *G. fausti* Tseng, 1933, has the same number (66) and arrangement of hooks as in *G. pagollae. Gyrocoelia fausti* was originally described as having 42–48 testes per proglottid but, according to Baer, may have as many as 55. In any event, *G. pagollae* with 20–30 testes may be differentiated on that basis from *G. fausti* and *G. australiense* which has as many as 50 testes, according to Maplestone and Southwell (1922). *Gyrocoelia albaredai* has an even greater number, 77–90, and, as described from a single specimen by Lopez-Neyra (1952), has auricular appendages on the scolex, shows pronounced hermaphroditism, lacks rostellar hooks, and on the whole is a much larger species than *G. pagollae.*

There remains but 1 species, *G. perversa,* from which the present one must be differentiated on bases other than scolex armature (unknown for *G. perversa*) and the number of testes, which is the same in the 2, according to Baer's (1940) reexamination of the type material of *G. perversa.* One evidently valid distinction is the diameter of the scolex and maximum width of the strobila which in *G. perversa* are over twice those in *G. pagollae;* moreover, our specimens were flattened under a slide during fixation, a procedure that enhances such dimensions. Another difference concerns the longitudinal muscle bundles, the numbers of which are given as 30 and 50 for *G. perversa* and are 90–124 and 62–72 for *G. pagollae* in the 3rd and 4th layers respectively. Furthermore, Professor J. G. Baer has examined the type specimen of *G. perversa* for us and definitely confirmed the presence of both testes and ovaries in the same strobila whereas such is not the case in *G. pagollae.*

Evidently species of *Gyrocoelia* differ greatly in the degree to which they exhibit sexual dimorphism, some being typically hermaphroditic and others functionally dioecious. It may be wondered if the situation is due to physiological factors

affected by the host environment, number of worms present and age of the infection instead of genetic differences. It is conceivable that in *G. pagolla,* a strobila could function as a male at one time and as a female at another, should all but the very young proglottids become detached and a new strobila form. For the individual of *G. pagollae* to be hermaphroditic under any other circumstances would necessitate phenomena that cannot be reconciled with our material.

There is disagreement as to the systematic position of *Gyrocoelia.* For it and certain other genera, Fuhrmann (1890) erected the subfamily Acoleinae and later (1907) elevated the group to family rank as the Acoleinidae, the spelling of which was changed to Acoleidae by Ransom (1909). Southwell (1930) removed from it the genus *Dioicocestus* for which he erected the family Dioicocestidae. Later, Burt (1939) transferred to that family from the Acoleidae the genera *Shipleya* and *Gyrocoelia,* and added *Infula* which probably is a synonym of *Gyrocoelia.* Although neither Fuhrmann (1932) nor Joyeux and Baer (1936) recognized the Dioicocestidae, the family with the genera assigned to it by Burt has been accepted by Wardle and McLeod (1952). Lopez-Neyra (1952) is of the opinion that the Acoleidae is an unnatural assemblage of aberrant cestodes and that *Gyrocoelia* links the Dilepididae and Tetrabothriidae. The taxonomy of these cestodes is in a most unsatisfactory state and is likely to remain so until experimental studies are brought to bear on their life histories, and an interpretation is made of protogynous, extremely protandrous, and dioecious forms.

SUMMARY

A species of *Gyrocoelia* from the naped plover, *Pagolla wilsonia rufinucha,* in Puerto Rico may be *G. milligani* but is distinct from the cestode described as that species by Baer and for that reason, is described provisionally as *G. pagollae* sp. nov. Original type material of *G. milligani* is too poor to make a final disposal of the matter. *G. pagollae* is dioecious with no evidence of female structures in male strobilae but proglottids of female worms contain well developed cirrus sacs and rudimentary sperm ducts. The rostellum is armed with 66 hooks in a zig-zag row with 6 corresponding angles.

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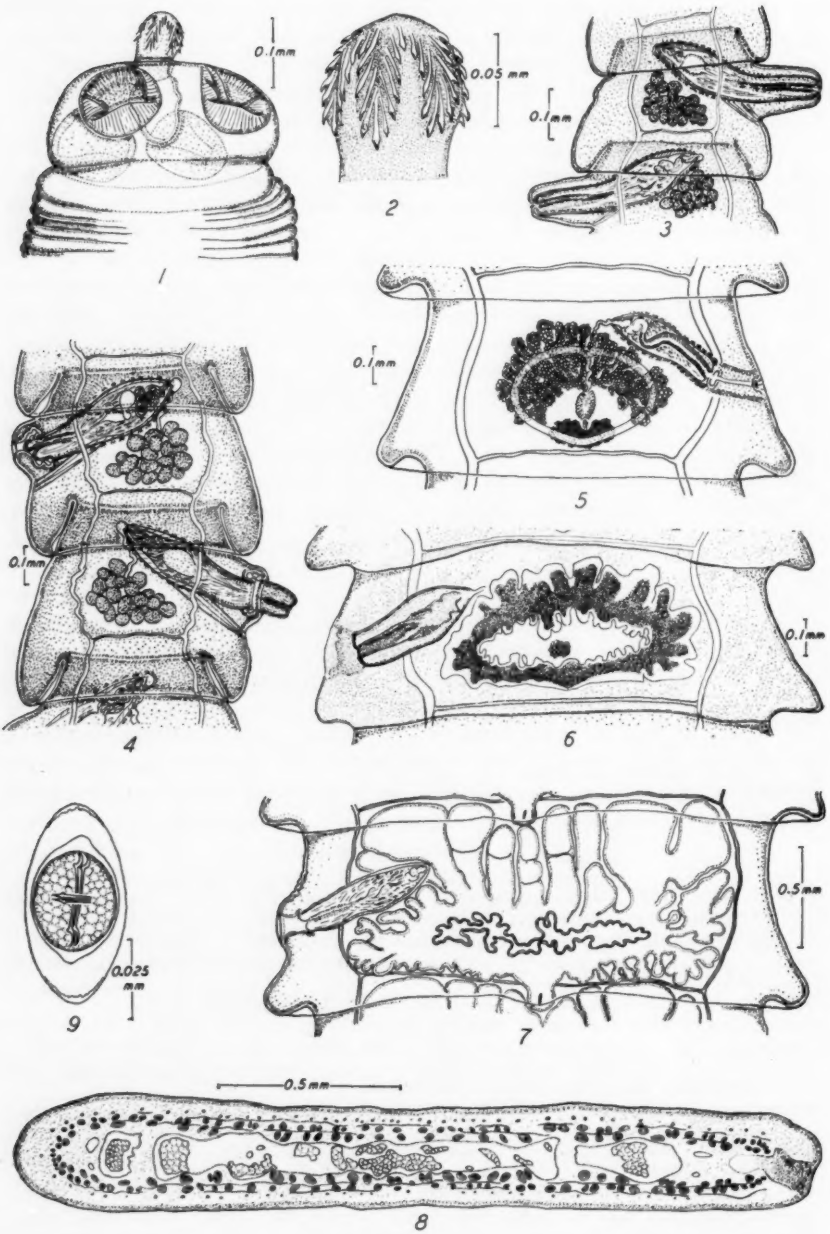
PLATE I



EXPLANATION OF PLATE

All figures concern *Gyrocoelia pagollae* sp. nov. provis.

FIGURE 1. Scolex and beginning strobila.

FIGURE 2. Rostellum enlarged to show hooks.

FIGURE 3. Portion of male strobila showing cirrus sacs protracted and genital atria everted, cirri retracted.

FIGURE 4. Same but with cirrus sacs retracted and genital atria distinct, one cirrus protruded.

FIGURE 5. Mature proglottid of female strobila.

FIGURE 6. Early gravid proglottid of female worm with eggs not yet completely formed.

FIGURE 7. Gravid proglottid with form of the uterus outlined.

FIGURE 8. Cross-section of early gravid proglottid showing number and arrangement of muscles.

FIGURE 9. Fully formed egg with embryo as seen in terminal proglottids of female strobila in totomount.

RESEARCH NOTE

PARASITISM IN KOREA

From August 1954 through April 1955 a parasitological survey of Korean and United Nations personnel (over 90% of whom were American) in the Seoul-Inchon area of Korea was conducted by the author at the 121st Evacuation Hospital and the 1st Medical Laboratory (Field) in Yong Dung Po, Korea. The survey was carried out on individuals who were either patients at the hospital or at other Army medical installations in the area, or food handlers.

Ritchie's ether-formalin concentration technique was employed. In most cases only 1 fecal specimen per person was obtained, and almost always the stools were too old to be examined satisfactorily for the trophozoites of amoebae and flagellates. Therefore, the prevalence of protozoan infections is lower than could be expected. For example, *Entamoeba coli* was found in only 19.8% of Koreans and 7.0% of U. N. personnel, and *E. histolytica* in 8.6% and 3.7% respectively. The findings of helminths are presented in Table I.

TABLE I. *Survey of parasitism in Korean and UN personnel*

	No. of persons examined	No. of persons positive	% of persons positive	
KOREAN	268	264	98.5%	
UN	601	135	22.5%	
PARASITE	**Korean No. positive**	**% positive**	**UN No. positive**	**% positive**
Trichuris trichiura	233	86.9%	38	6.3%
Hookworm	172	64.2%	36	6.0%
Ascaris lumbricoides	123	45.9%	6	1.0%
Trichostrongylus sp.	62	23.1%	1	—
Clonorchis sinensis	33	12.2%	1	—
Metagonimus yokogawai	5	1.9%	—	—
Heterophyes heterophyes	2	—	—	—
Hymenolepis nana	1	—	3	—
Strongyloides stercoralis	1	—	5	—
Schistosoma mansoni	—	—	3	—

Eggs of *Paragonimus westermani* and *Enterobius vermicularis* were also encountered on rare occasions, but as they are not usually found in fecal examinations they have not been included in the table. *P. westermani* was not found in any UN person.

It is not known how much parasitism was acquired in Korea by the UN personnel. However, the table illustrates the great difference in the incidence of parasitism between the Korean and UN personnel, particularly Americans. This difference indicates that the high degree of parasitism in the native population poses no serious threat to the health of the United States. military personnel during a period of peace. This is undoubtedly due to the marked differences in living conditions and eating habits of the two peoples.

The author wishes to thank those members of the Army and Air Force Medical Service in Korea whose cooperation made this work possible.—ELLIOTT LESSER, 1st Lt. MSC, *Fourth Army Area Medical Laboratory, Fort Sam Houston, Texas.*

LIFE HISTORY OF THE TICK *DERMACENTOR PARUMAPERTUS* IN UTAH[1, 2]

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The tick *Dermacentor parumapertus* Neumann is considered to be of great importance as a potential vector in epizootics in the Great Basin area in Utah for the following reasons: (1) It has wide geographic distribution; (2) it is relatively abundant on many kinds of mammals, being the most common tick of the lower elevations of this region; (3) in nature it is known to harbor the bacteria of tularemia, the virus of Colorado tick fever, and a rickettsia similar to that which causes spotted fever (Philip and Hughes, 1953); and (4) it has been experimentally shown to transmit Rocky Mountain spotted fever (Maver, 1911; Parker, Phillip, and Jellison, 1933), and tularemia (Parker *et al,* 1937).

Early observations on its life history, bionomics and distribution were published by Hooker, Bishop and Wood (1912). More recent information based on Utah material was obtained by Stanford (1934), Edmunds (1951), Coffey (1954), Fremling and Gastfriend (1955), Gastfriend (1955), Beck (1955), and Allred and Roscoe (unpublished observations). The present paper presents the results of studies of certain phases of the life cycle and biology of this tick in the Great Basin in Utah (see Tanner, 1954) not completely covered by those workers cited above.

Adult ticks of this species have been found in great numbers only on the black-tailed jack rabbit. Coffey and Gastfriend have shown that the larval and nymphal stages occur on 12 or more kinds of rodents, including kangaroo rats, *Dipodomys microps.bonnevillei* Goldman and *D. ordii pallidus* Durrant and Setzer. These rats frequently are infested by great numbers of these immature ticks, and probably are their most common hosts in the area of the Great Basin. The body structure and manner of locomotion of the rats seem ideally adapted for this host-parasite relationship. Experiments in the laboratory have shown that their long penicillate tails act as collecting brushes, sweeping the ground and picking up great numbers of larval and nymphal ticks.

The frequent host-parasite association between *D. parumapertus* and the kangaroo rats led to the belief that these small rodents could be utilized for rearing ticks. Subsequent use has demonstrated their applicability for this purpose as well as for other laboratory experiments. They are abundant, easy to handle, have minimum water and simple dietary requirements, and are adaptable to confinement.

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[2] We are grateful to Dr. Angus M. Woodbury, Director, and other members of Ecological Research for their help and suggestions during the course of these investigations.

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MATERIALS AND METHODS

Kangaroo rats trapped in the field were kept in round glass specimen jars, 7 inches high and 7 inches in diameter. The bottom of each jar was covered with a shallow layer of sand and the top closed with quarter-inch, galvanized wire mesh which restricted the rats but allowed easy insertion of food, water and ticks.

Initially, larval and nymphal ticks and their hosts were kept closely confined in a muslin bag for several hours to facilitate attachment of the ticks. In other experiments the ticks were simply introduced into a glass jar with the rat. Little difference in efficiency between these 2 methods was observed. A special attachment tube that increased the efficiency of attachment was later devised (Fig. 1). This apparatus consists of an open-topped cylinder of hardware cloth enclosed in a shipping container with a lid from which a circle has been replaced with a copper wire screen.

FIGURE 1. Apparatus to facilitate attachment of ticks to rats.

Jars containing rats infested with larval and nymphal ticks were placed into white enamelware pans, 10 and 14 inches in diameter and 3 and 6 inches deep, one inside the other (Fig. 2). In order to prevent the escape of unattached ticks and to facilitate the recovery of engorged ticks, each pan was filled with water to a depth of approximately 1 inch. Ticks that escaped from the jar were trapped by the water; those that remained in the jar were recovered by screening the sand through a 40-mesh screen that allowed the sand to pass, but retained the ticks. Recovery operations were begun on the first day that engorged ticks were observed in the sand or water, and were continued daily until no engorged ticks were found.

The experiments were initiated with 147 engorged female ticks recovered from the black-tailed jack rabbit, *Lepus californicus deserticola* Mearns, shot in the vicinity of Dugway Valley, Tooele County, Utah during July, 1954. Most of the ticks

FIGURE 2. Apparatus for holding tick-infested rats.

were detached from the rabbits by use of eye-muscle forceps; others were collected after they had detached normally. The most common site of attachment of the adult ticks appears to be about the head. In this area, during July and August, engorged adult ticks frequently occur on the ears and face of the jack rabbit in such great numbers that they resemble clusters of grapes. Hooker *et al* observed relatively few engorged ticks on wild rabbits presumably obtained from outside this area.

Each engorged adult female tick was put into a 2-dram glass vial stoppered with a wad of cotton wrapped in cheesecloth. The ticks produced a total of more than 100,000 eggs which were reared through the succeeding larval, nymphal and adult stages. The vials were stored in closed desiccator jars at approximate relative humidities as follows: (1) Adult ticks and their eggs of 1 series were kept at 95% R.H.; (2) those of a second series were kept at 81% R.H. Between feedings and during periods of molting, the larvae and nymphs of both series were kept at 81% R.H. All ticks were kept at room temperature, which probably fluctuated considerably for a portion of the day despite air-conditioning of the building. This temperature variation probably resulted in only slight fluctuations of the relative humidity in the chambers. Hooker *et al* kept temperature data in their rearing experiments, but except for the statement that the ticks were kept over moist sand, they did not mention any specific relative humidity.

In order to eliminate the tedious task of counting the numbers of eggs produced by each female tick, the numbers were estimated by weight of the egg mass. After the ticks had oviposited, the weights of 5 random samples of 100 eggs per sample were determined. From these figures it was calculated that the average weight per egg was 0.08 mg. The total number of eggs laid by each tick was computed by dividing the total weight of the egg mass by this average. The accuracy of this

method was checked by making an actual count of the eggs laid by 10 ticks selected at random, compared with the estimate made by weight computation. The number of eggs computed by weight of the egg mass differed from the actual count by 0.046%; hence this method is believed to be reasonably reliable.

OVIPOSITION AND EGG DEVELOPMENT

Commencement of Oviposition. Of the 147 engorged females collected in the field, 93 laid eggs; 54 failed to oviposit. The elapsed time from detachment to commencement of oviposition of 53 ticks kept at room temperature and at 81% R.H. varied from 7 to 20 days; average 10 days. Of the 53 that oviposited, 17 weighed less than 100 mg; only 3 of those failing to oviposit exceeded this weight. Forty-five of those failing to oviposit weighed less than 60 mg. No failures to oviposit were noted for ticks weighing more than 200 mg.

At room temperature and at 95% R.H. the elapsed time from detachment to commencement of oviposition of 40 ticks varied from 5 to 12 days; average 7 days. The ticks kept at this humidity were not weighed. At a mean temperature of 85° F in July, Hooker *et al* found that ticks began oviposition on the fifth and sixth days after detachment from a host.

Post-ovipositional life span. Although female ticks usually died within 1 to 6 days after oviposition had been completed, some lived as long as 2 weeks.

Number of eggs deposited. The numbers of eggs deposited by individual ticks varied from 30 to 6587. Hooker *et al* did not give a minimum figure but recorded a maximum of 4660. It is likely that a fully engorged female will produce more than 7000 eggs under favorable conditions of temperature and humidity.

Correlation of number of eggs and degree of engorgement. One hundred and seven adult ticks in different degrees of engorgement were weighed individually within 12 hours after they were removed from rabbits collected in the field. The maximum weight recorded for any one tick was 515 mg. The results indicate a direct correlation between the degree of engorgement and the number of eggs deposited (Fig. 3). The 10 recorded cases in which the numbers of eggs fell considerably below the expected ratio can not be explained, unless during forced removal from their hosts they were injured in such a manner as to affect their oviposition.

Using the weights of unengorged adult female ticks (2.3 mg) and of fully engorged ticks (515 to 600 mg) as a basis, it was calculated that some ticks oviposited when only about 7% engorged; the majority were at least 11% to 15% engorged.

Egg size. The majority of the ellipsoidal eggs of this tick were about 0.5 mm long and 0.4 mm in diameter. When large numbers of eggs were deposited by a tick, some eggs were significantly larger than the others. These larger eggs (approximately 0.66 mm by 0.50 mm) occurred at a rate of 1 egg in approximately 225. It is not known whether the larger eggs, equivalent in size to those measured by Hooker *et al*, were of normal occurrence or were abnormal because of environmental conditions of the laboratory. No observations were made to determine whether the larvae from the larger eggs differed from those from the smaller eggs.

Incubation period. At a relative humidity of 81%, the incubation period of the eggs varied from 28 to 37 days; average 32 days. At 95% R.H. the incubation period varied from 26 to 36 days; average 31 days. These results indicate a longer

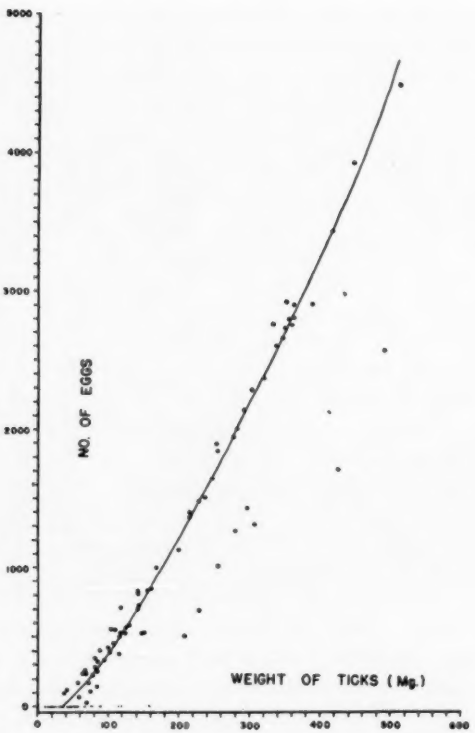

FIGURE 3. Correlation of engorgement of ticks and number of eggs laid.

incubation time than the 20 days observed by Hooker *et al.* In 7 instances all of the eggs failed to develop; 5 of these cases involved eggs produced by ticks weighing less than 76 mg. Occasionally only a few eggs of a large number failed to hatch, probably due to non-fertilization.

LARVAE

Periods and sites of attachment. The ages of the 38,866 larvae that were applied to the kangaroo rats varied from 9 to 44 days. Although no special experiments were undertaken to determine how early newly hatched larvae will attach to a host, the 9-day old larvae readily attached. Larval ticks attached almost any place on the body of the rat. Common sites were at the base of the tail and around the head, especially on the backs of the ears and at the bases of the vibrissae. The numbers of larvae recovered after their introduction and subsequent engorgement on the rats were at times relatively small. Of the total number of larvae applied, as few as 3% and as many as 76% were recovered in an engorged condition. Frequently ticks crawling on the body, as well as attached ticks, were scratched off. Some of these were eaten, a fact which may account for the low percentage of the engorged ticks recovered. This finding is in agreement with the work of Hooker *et al* who suggested that the hosts scratch off great numbers of ticks before they have an opportunity to attain complete engorgement.

Period of engorgement. The period of engorgement of the larvae varied from 4 to 13 days. Ninety-two per cent of the engorged larvae dropped from their host by the seventh day, and after the thirteenth day no engorged larvae were recovered. The majority of the recovered larvae attached, engorged and dropped from the host by the eighth day after introduction. Hooker *et al* found that engorgement was completed as soon as the fourth day after attachment, whereas some ticks continued to engorge for more than 14 days. These variations of time may be due to host or parasite peculiarities or a delay in attachment.

Molting period. Engorged larvae required from 7 to 16 days after dropping from the host before they molted to nymphs; the average was 9 days. Hooker *et al* observed that the larval requirement for molting to nymphs varied from 8 to 47 days.

NYMPHS

Period and sites of attachment. The ages of 1028 nymphs that were applied to the kangaroo rats varied from 15 to 33 days. Although no experiments were undertaken to determine how early nymphs attach after molting from larvae, the 15-day old nymphs readily attached. The most common sites of attachment of the nymphs were the sides of the head, around the eyes and ears, and at the bases of the vibrissae. The engorged nymphs that were recovered constituted only 2% to 37% of the total nymphs applied. Seventy-seven per cent dropped from the host by the ninth day, and after the thirteenth day no engorged nymphs were recovered. As noted previously, the host's habit of scratching the ticks off the body and eating them may partially account for the low percentage of nymphs recovered.

Period of engorgement. Fully engorged nymphs dropped from their hosts as early as 6 days after attachment; a few continued to engorge as long as 14 days. Hooker *et al* found that the period of engorgement of the nymphs varied from 4 to 25 days. As in the case of the larvae, these variations may be due to peculiarities of the host or parasite or a delay in attachment.

Molting period. The time required for nymphs to molt to adults varied from 17 to 28 days; average 25 days. Hooker *et al* found that some engorged nymphs molted as soon as 21 days after dropping from the host; others required as long as 123 days. The sex of the nymph had little or no influence on molting time. This confirms observations made originally by Hooker *et al.*

SUMMARY

The tick *Dermacentor parumapertus* Neumann is considered to be of great importance as a potential vector in epizootics in the Great Basin area in Utah because of its wide geographic distribution, relative abundance, and known disease implication. The immature ticks are known to occur on 12 or more kinds of rodents, and the adults have been found in great numbers only on the black-tailed jack rabbit.

A total of 147 engorged ticks recovered from jack rabbits produced a total of more than 100,000 eggs in the laboratory. At room temperature and at 81% relative humidity, adult ticks commenced oviposition from 7 to 20 days after removal from their hosts. At room temperature and at 95% R.H., oviposition began from 5 to 12 days after removal from the host. Female ticks lived as long as 2 weeks after completion of oviposition. The numbers of eggs deposited by an individual

tick varied from 30 to 6587. Some engorged ticks were found to attain weights in excess of 500 mg. There was a direct correlation between the degree of engorgement and the number of eggs deposited. Ticks were able to lay eggs when only about 7% engorged, but the majority did not oviposit unless they were at least 11% to 15% engorged. Most of the eggs were 0.50 mm long and 0.40 mm in diameter. Larger sized eggs (0.66 mm by 0.50 mm) were oviposited at a ratio of 1 egg in approximately 225.

At 81% R.H., the incubation period of the eggs varied from 28 to 37 days; at 95% R.H., from 26 to 36 days.

Nine-day old larvae readily attached to kangaroo rats and attained complete engorgement in 4 to 13 days. Engorged larvae molted in 7 to 16 days after dropping from their host.

Fifteen-day old nymphs readily attached to kangaroo rats and attained complete engorgement in 6 to 14 days. Engorged nymphs molted in 17 to 28 days after dropping from these hosts. The sex of the nymphs had little or no influence on molting time.

Attachment and engorgement time and other feeding habits of the adults in the area of the Great Basin in Utah are as yet little known.

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TREMATODES OF FISHES FROM THE RED SEA. PART 7. ON TWO GYLIAUCHENIDS AND THREE ALLOCREADOIDS, INCLUDING FOUR NEW SPECIES.*

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The following trematodes were collected by the author in Egypt. Their study was completed at the University of Nebraska during the tenure of a Fulbright Research Scholarship in 1953–1954.

Type species are in the Parasitology Department, Faculty of Medicine, Abbasia, Cairo, Egypt.

All measurements are in millimeters.

FAMILY GYLIAUCHENIDAE

Gyliauchen volubilis n. sp.
(Figs. 1–3).

Thirteen specimens were obtained from *Pseudoscarus harid,* locally called "Harit," and from *Amphacanthus sigan,* locally called "Sigan," from Ghardaga. Only 1 specimen (in the first host) was fully mature; others had few eggs or were immature.

Description: Conical, fleshy trematodes tapering anteriorly, convex dorsally, concave ventrally, with small tail-like protuberance postero-dorsal to acetabulum. Fully mature specimen 3.12 long by 1.18 in greatest width. Specimens with few eggs, 1.36 to 1.74 long by 0.44 to 0.49 wide. Cuticle smooth. Acetabulum at posterior end, more or less spherical; 0.63 in diameter in largest specimen, 0.19 to 0.26 in others; aperture I-shaped. Oral sucker embedded in parenchyma, pyriform, 0.4 long by 0.29 wide in fully mature specimen; mouth narrow, subventral. Prepharynx very long and convoluted, occupying greater part of anterior half of body; about 5× direct distance between oral sucker and pharynx; direction of coils constant as shown in Fig. 3 with course indicated by arrows; coils in two levels, the ventralmost resembling a reversed letter C, followed by a more dorsal counter-clockwise C-shaped loop which is followed by an inverted U coil. Pharynx 0.14 to 0.17 by 0.14, overlapped ventrally by dorsalmost coil of prepharynx, close to intestinal bifurcation. Posterior border of pharynx at about mid-body level. Intestinal ceca short, broad, and ending just anterior to gonads at about junction of 3rd and 4th quarters of body length. Testes 2, spheroid, smooth, 0.19 to 0.55 in diameter, situated in posterior fourth of body length, dorsal to acetabulum, left testis slightly in advance of right. *Vesicula seminalis externa* well developed; cirrus sac pyriform; prostate gland a large cluster of cells outside and posterior to cirrus sac. Genital pore median, a short distance posterior to mid-body level. Ovary median, between testes, spheroid, 0.1 to 0.14 in diameter. Seminal receptacle and Mehlis' gland near ovary. Vitelline glands well developed, extending from near oral sucker to anterior border of gonads. Uterus short, with few coils between ovary and genital pore; eggs few, large, ovoid, 0.09 by 0.05. Excretory vesicle small, pyriform, extending anteriorly to posterior border of testes, opening at tip of excretory protuberance. The lymphatic system was not observed, except perhaps the anterior ends of the canals in some specimens.

Discussion: Although the ovary of *Gyliauchen volubilis* is between the testes, it is slightly more anterior than in the genus *Flagellotrema* Ozaki, 1936. In that genus, the ovary is posterior to the anterior testis which is at some distance from the other, with both testes anterior to the acetabulum. In the genus *Gyliauchen,* the ovary is described as anterior to the oblique testes. In *G. volubilis,* the testes are dorsal to the acetabulum and the position of the ovary is intermediate to that described for *Flagellotrema* and *Gyliauchen.* The topography of the gonads is on

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* Studies from the Department of Zoology, University of Nebraska, No. 287.

the whole more like that of *Gyliauchen* and for that reason the present species is assigned to that genus. *G. volubilis* resembles most *G. papillatus* (Goto and Matsudaira, 1918) Goto, 1919, but differs from that species: (a) in the more posterior position of the ovary; (b) in the greater development and extent of the vitellaria; (c) in the constant disposition of the pre-pharyngeal convolutions which are also longer and more voluminous; (d) in the better developed excretory protuberance.

Apharyngogyliauchen callyodontis Yamaguti, 1942
(Figs. 4 & 5)

Sixty-eight specimens identified as *Apharyngogyliauchen callyodontis* were recovered from the intestine of *Pseudoscarus harid*, locally called "Harit" or "Wariga," from Ghardaga. Although the material differs from Yamaguti's (1942) description in the size of the body and suckers, and in the size, shape and location of the ovary, these differences are considered to be of minor importance. The following description applies to the species as it occurs in the Red Sea and supplements the account based on specimens from Japan.

Description: Body 2.15 to 3.89 long and 1.08 to 2.17 in maximum width; pyriform, tapering anteriorly; posterior end rounded in flattened specimens seen from ventral aspect. Cuticle smooth. Acetabulum 0.57 to 0.93 in diameter, subterminal at posterior end. Oral sucker embedded in parenchyma, subterminal, ovoid, 0.26 to 0.44 in diameter; post-oral ring and pharynx absent; esophagus fairly long, without convolutions, surrounded by numerous glands which may be clustered more densely anteriorly. Esophagus joins two, simple, broad, intestinal ceca at about junction of anterior and middle thirds of body. Ceca short, extending through approximately middle third of body and just reaching or slightly overlapping anterior border of testes. Testes 2, ovoid, smooth, opposite or sometimes one slightly anterior to other, at posterior end, dorsal to acetabulum. Testes in mature specimens 0.38 to 1.03 by 0.31 to 0.65 in diameter with the long axis directly obliquely antero-posteriorly; in immature forms they may be irregular in shape and slightly indented (Fig. 5). *Vesicular seminalis* entirely outside cirrus sac, elongated, sometimes divided into 2 parts by a constriction. It may be straight in young specimens or V-shaped in mature ones. Cirrus sac pyriform, containing a fan-shaped pars prostatica and well developed cirrus. Prostatic cells surround distal third of *vesicula seminalis* and proximal half of cirrus sac. Ovary subtriangular, 0.18 to 0.32 in diameter, situated anterior to testes slightly to one side of mid-line and from just anterior to acetabulum to level of cirrus sac. Well developed Mehlis' gland and large seminal receptacle near ovary. Vitellaria of irregularly shaped follicles of medium size, lateral, between levels of oral sucker and testes and confluent medianly in anterior third of body. Uterus short, with a few intercecal convolutions anterior to acetabulum, opening medially near male pore at about mid-body level. Eggs 0.07 to 0.09 by 0.04 to 0.06, ovoid, colorless.

LEPOCREADIIDAE

Bianium tetrodontis n. sp.
(Figs. 6 & 7)

Eighteen specimens were collected from *Tetrodon reticularis* at Ghardaga. Only 3 were fully mature with eggs in the uterus.

Description: Small, ovoid worms, with undulant posterior edge. Anterior fold extends as far back as acetabulum or even more posteriorly in young individuals. No spines were observed. The following measurements are based on 3 fully mature specimens: 1.5 to 1.9 long; 1.17 to 1.39 in maximum width. Suckers equal or subequal, 0.22 to 0.29 in diameter. Acetabulum at or slightly posterior to mid-body level. Oral sucker subterminal, opening ventrally between body folds and followed immediately by pharynx as large as or even larger than oral sucker, measuring 0.19 to 0.28 by 0.22 to 0.31, provided with 8 small lobes anteriorly. Prepharynx and esophagus lacking; intestinal ceca arched, comparatively wide, with 2 to 7 pocketings on shoulders and narrowing posteriorly to open through ani. Testes 2, spherical or ovoid, smooth, 0.26 to 0.66 in diameter; situated in posterior third of body between ceca or overlapped by one or both, opposite or slightly oblique in arrangement. Cirrus sac comparatively long, measuring 0.66 to 0.73, extending anteriorly from well posterior to acetabulum, and around that sucker either to the right or left, to open at the genital pore near posterior edge of pharynx; well developed internal and external seminal vesicles, the latter approaching testis of its side. Ovary median, pretesticular, intercecal, with about 17 lobes in mature specimens: large seminal receptacle near ovary. Vitelline follicles occupy greater part of body, extending anteriorly as far as pharynx. Uterus short, median, preovarian, intercecal; eggs few, relatively large, measuring 0.07 by 0.04.

Discussion: *Bianium tetrodontis* is closest to *B. plicitum* (Linton, 1928) Stunkard, 1931 (synonym: *B. adplicatum* Manter, 1940), but differs from that species in the following respects: smaller and ovoid in shape; spines or scales lacking; acetabulum at or posterior to mid-body level; pharynx as large as oral sucker; prepharynx and esophagus lacking; testes opposite or slightly oblique; cirrus sac longer; greater extent of vitellaria anteriorly; eggs larger.

OPECOELIDAE

Cainocreadoides serrani n. g., n. sp.
(Fig. 8)

Fourteen specimens were obtained from *Serranus* sp. and *Lethrinus nebulosus*, locally called "Koshar" and Sho-oura" respectively, from Ghardaga.

Description: Body tapering toward both ends, 2. to 4. long by 0.6 to 1.27 in maximum width. Cuticle smooth. Acetabulum 0.3 to 0.42 by 0.37 to 0.54; at junction of anterior and middle thirds of body length. Oral sucker sub-terminal 0.2 to 0.29 in diameter; pharynx elongate, 0.123 to 0.23 long by 0.11 to 0.16 wide; esophagus fairly long; simple intestinal ceca terminate near posterior end of body. Testes 2, smooth, oblique, just within posterior half of body. Cirrus sac not extending posterior to acetabulum, containing seminal vesicle. Genital pore median, at intestinal bifurcation. Ovary multilobed (4–9), immediately anterior to anterior testis, at middle of body and to right side of median plane; seminal receptacle well developed; vitellaria filling considerable part of neck region and extending to posterior end of body. Uterus preovarian with comparatively few eggs; metraterm muscular, sinuous, distinct. Eggs golden yellowish, ovoid, without filaments, 0.077 to 0.05. Excretory vesicle simple, reaching to acetabulum.

Discussion: *Cainocreadoides* is nearest to *Cainocreadium* Nicoll, 1909 from which it differs in the following respects: testes oblique; ovary multilobed; muscular metraterm; elongate pharynx. To this genus should be added *Hamacreadium epinepheli* Yamaguti, 1934 which becomes *Cainocreadoides epinepheli* (Yamaguti, 1934) n. comb. *H. epinepheli* was previously considered by the present author (Nagaty, 1941) to be a synonym of *H. mutabile* Linton, 1910 but is now believed to be a distinct species. It differs from *C. serrani* in the more posteriorly situated acetabulum, less anterior extent of the vitellaria and more anterior extent of excretory vesicle.

The median genital pore distinguishes *Cainocreadoides* from *Hamacreadium* and *Plagioporus*.

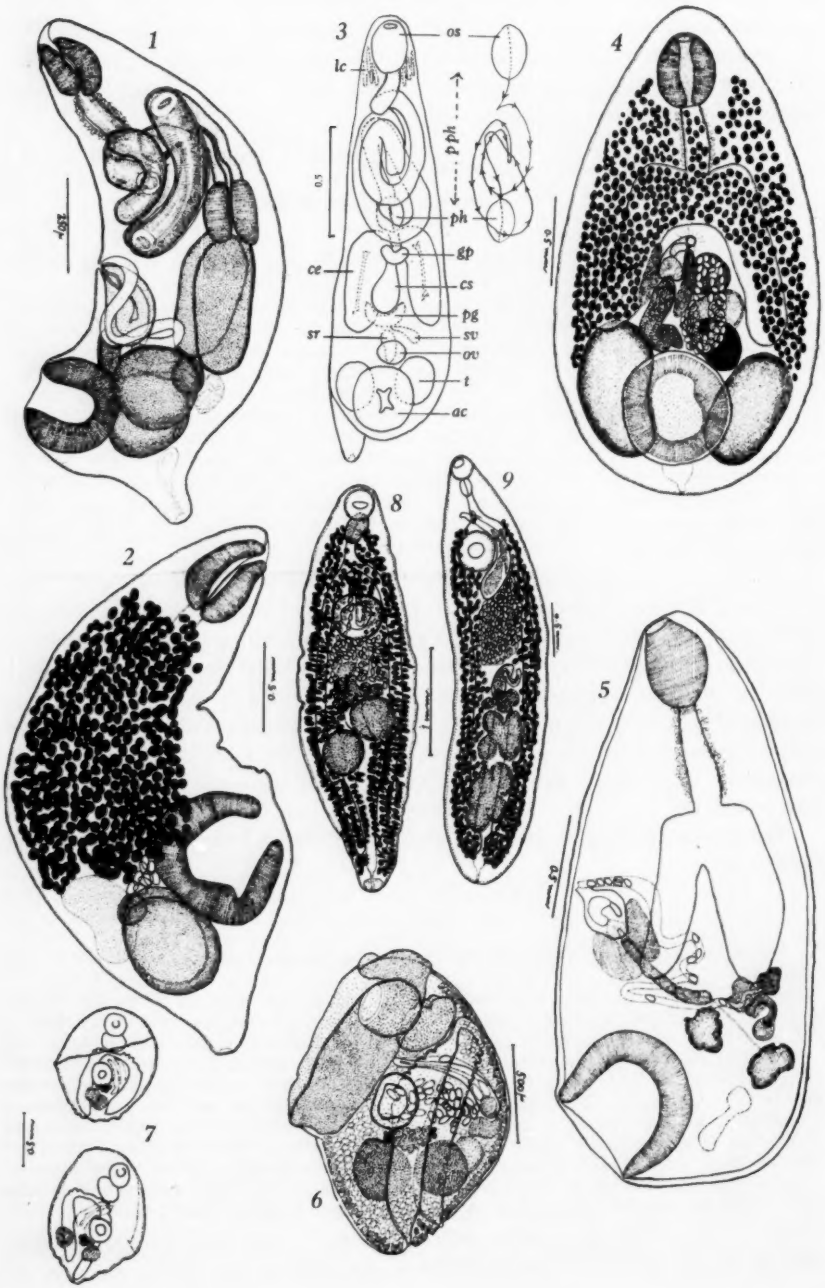
Helicometra boseli n. sp.
(Fig. 9)

Twenty specimens were obtained from *Holocentrus samara*, locally called "Boseli," from Ghardaga.

Description: Body elongate, with nearly parallel sides, narrowing anteriorly, 2.7 to 4.09 long by 0.39 to 0.99 in maximum width. Acetabulum slightly larger than oral sucker, 0.23 to 0.36 in diameter, situated mostly at anterior quarter of body length. Oral sucker 0.193 to 0.22 in diameter; pharynx well developed; esophagus of medium length; ceca end 0.35 from posterior end of body. Testes 2, in posterior half of body, irregularly lobed, usually tandem but may be slightly oblique. Cirrus sac 0.51 to 1.02 long, extending well posterior to acetabulum, containing a winding *vesicula seminalis interna*. Genital atrium median, a little anterior to acetabulum. Ovary typically 4-lobed, median, directly anterior to anterior testis; seminal receptacle large, retort-shaped, anterior to ovary. Vitellaria abundant, lateral, extending from anterior edge of acetabulum to posterior end of body. Uterus preovarian; eggs yellowish, with antopercular filament 4–5 times as long as egg proper which measures 0.05 by 0.035.

Discussion: Helicometra boseli differs from any known species of the genus in that the cirrus sac extends well posterior to the acetabulum.

PLATE I



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EXPLANATION OF PLATE

Abbreviations: *ac*, acetabulum; *cs*, cirrus sac; *gp*, genital pore; *lc*, lymph canal; *ov*, ovary; *os*, oral sucker; *pg*, prostate gland; *ph*, pharynx; *pph*, prepharynx; *sv*, seminal vesicle; *t*, testis.

FIG. 1. *Gyliauchen volubilis.* Lateral view. Vitellaria omitted.
FIG. 2. *G. volubilis.* Lateral view to show vitellaria.
FIG. 3. *G. volubilis.* Outline and diagram to show course of prepharynx.
FIG. 4. *Apharyngogyliauchen callyodontis* Yamaguti, 1942. Ventral view.
FIG. 5. *A. callyodontis.* Lateral view.
FIG. 6. *Bianium tetrodontis.* Ventro-lateral view.
FIG. 7. *B. tetrodontis.* Immature specimens.
FIG. 8. *Cainocreadoides serrani.* Ventral view.
FIG. 9. *Helicometra boseli.* Ventral view.

RESEARCH NOTE

A RABBIT TICK, *DERMACENTOR PARUMAPERTUS*, ATTACHED TO MAN

The tick *Dermacentor parumapertus* Neumann is known to infect approximately 20 kinds of mammals, primarily rabbits and rodents. Man is not included in several recent comprehensive host lists (Beck, 1955, Brigham Young Univ. Sci. Bull., Biol. Ser. **1**: 1–64; Coffey, 1954, Great Basin Nat. **14**: 31–37; Gastfriend, 1955, J. Parasit. **41**: 63–65). Except for the inconclusive statement by Neumann (1901, Revision de la Ixodides, Extr. des Mem. Soc. Zool. de France) that the type specimens "were taken on a man . . .," I have been unable to find any published account relating to the actual attachment of *D. parumapertus* to *Homo sapiens.*

Over the past 3 years the personnel of Ecological Research, University of Utah, Dugway, Utah, have handled thousands of host animals during routine collecting and processing procedures, and have come in close contact with hundreds of thousands of these ticks in the course of laboratory investigations. During this period only a single case of actual attachment to man has been observed. This may indicate that a host preference factor is operating rather than mere lack of opportunity to attack man.

On the evening of June 8, 1955, a male *D. parumapertus* was found attached to the upper portion of my left thigh (identification confirmed by D. M. Allred, Arachnologist, Ecological Research. The specimen has been deposited in our reference collection, Arachnology No. 3265). Earlier in the day I had come in contact with a number of unengorged adults in the course of experimental life history studies. After the forceable removal of this tick, a slight itching sensation, much like that caused by a mosquito bite, was felt at the site of attachment. The itching disappeared in about two hours and no other effects were noted.

Dermacentor parumapertus is widely distributed in the southwestern United States. These ticks have been found naturally infected with a spotted fever-like Rickettsia and the pathogens of tularemia and Colorado tick fever (Philip and Hughes, 1953, VIth Congr. Internaz. Microbiol., Sez. VIII–XVI, **2** (793): 600). Experimental studies have shown this species to be as capable of transmitting spotted fever strains as *D. andersoni* (Philip and Hughes, 1953). For these reasons it is regarded by Beck (1955) as the most important potential vector of Rocky Mountain spotted fever in the Great Basin area of Utah. It would also be of more than passing interest to know what role, if any, this tick plays in the maintenance of tularemia epizootics in areas utilized for winter grazing by the sheep industry (see Jellison and Kohls, 1955, Publ. Health Monogr. 28, 17 pp.; Meyer, 1955, The Zoonoses in their Relation to Rural Health. Univ. Calif. Press, Berkeley, 49 pp.).

This work is supported by BW Assessment Laboratories, Army Chemical Corps at Dugway, Utah.—ERNEST J. ROSCOE, *Ecological Research, University of Utah, Dugway, Utah. Present address: Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

EFFICACY OF ABBOTT'S INSECT REPELLENT CREAM (E4856) IN PREVENTING *SCHISTOSOMA JAPONICUM* INFECTIONS IN MICE

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Bauman, Berrios-Duran and McMullen (1955) have reported that Abbott's Insect Repellent Cream (E4856) in topical applications provided marked protection to mice exposed to *Schistosoma mansoni* cercariae. The purpose of the present paper is to report results obtained in tests to determine the effectiveness of the compound against cercariae of *S. japonicum*.

MATERIALS AND METHODS

Mice used in these tests were young adult males and females of generally uniform size. Cercariae of *S. japonicum* were obtained from naturally infected *Oncomelania nosophora* snails that were collected in an endemic center in Yamanashi Prefecture, Japan. Pools of cercariae from five or more infected snails were used for each of three tests. A sample of repellent cream was furnished by Dr. D. B. McMullen. The formula of the repellent as given by Bauman *et al.* (1955) is: 2% Rutgers 612, 2% Indalone and 6% dibutyl phthalate in a plasticized compound of silicone, nitrocellulose and castor oil in a vanishing cream base.

In each of three tests, mice which had been prepared 24 hours previously by shaving their backs were divided into one control and two experimental groups. Approximately 0.1 gram of repellent cream was rubbed into the skin of the back of mice in the experimental groups; control mice were not treated with the repellent. At specified times thereafter each mouse was exposed to 30 cercariae that had been counted out accurately into watch glasses containing about 0.5 ml. of water. An effort was made to insure complete exposure by repeatedly touching the back of the mouse to the surface of the cercarial suspension. This was continued until cercariae could no longer be observed in the watch glass. The timing of repellent application and exposure to cercariae was so arranged that all cercariae required for each test could be obtained from the same pool. After exposure the mouse was handheld until its back had dried. The control group and the two experimental groups were housed in separate cages. Mice were not maintained individually, nor were their activities restricted in any way.

All mice were sacrificed 4 to 5 weeks after exposure to cercariae. Schistosomes were recovered by a perfusion technic combined with intensive examination of tissues. The perfusion technic used was essentially that of Pan and Hunter (1951) with the exception that pressure on the perfusing medium was controlled by bottled air instead of a syringe.

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RESULTS AND DISCUSSION

Results obtained in three tests are summarized in Table I. The protection afforded by the repellent cream against *S. japonicum* cercariae was not absolute since infections were not prevented in every instance. Eighty percent and 71.6% of the mice in two groups were completely protected from infection when exposed to cercariae 6 hours after application of the repellent, while after 12 hours, 64% were protected. These data were compared with those from the appropriate control groups by Chi-Square with Yates' correction for continuity. The analysis indicated that a significantly large number of experimental mice received complete protection from cercariae.

The repellent was effective for at least 24 hours. Groups of mice exposed to cercariae 6, 12 and 24 hours after application of repellent had significantly lighter worm burdens ("t" test) than the respective control groups (Table I). The lighter

TABLE I.—*Protection afforded by topical application of Abbott's Insect Repellant Cream (E4856) against* Schistosoma japonicum *infection in mice. All mice exposed to 30 cercariae*

Test no.	Interval between treatment and exposure (Hours)	No. mice	Percent infected	Percent totally protected	Adult worms recovered		Significance level (Controls vs. experimentals)	Relative worm burden reduction (Percent)
					Mean	S.D.		
1	—(Controls)	5	80.0	20.0	18.6	11.26		
	6	5	20.0	80.0	0.4	0.894	.01–.001	97.8
	30	5	80.0	20.0	8.0	6.819	.2–.1	57.0
2	—(Controls)	14	100.	0.0	16.7	6.156		
	6	14	28.6	71.4	0.7	1.204	< .001	95.7
	30	14	100.	0.0	11.57	5.5	.05–.02	30.8
3	—(Controls)	16	100.	0.0	22.8	2.4		
	12	14	36.0	64.0	1.14	1.83	< .001	95.6
	24	14	57.0	43.0	3.1	4.2	< .001	87.9

worm burdens represent reductions ranging from 97.8% in the 6-hour group to 87.9% in the 24-hour group. Apparently the effectiveness of the repellent was lost very quickly after 24 hours since mean worm burdens in two groups of mice exposed after 30 hours were not significantly different from the controls, and worm burden reductions amounted to only 30.8% and 57.0% in the two test groups.

The tests described here differ considerably in method from those performed by Bauman *et al.* (1955). In the latter instance animals were exposed to cercariae by the tail immersion method and aliquots of a standard suspension of cercariae were used for the exposures. Furthermore, mice exposed 1 and 6 hours after application of repellent were held in continuous restraint. Bauman *et al.* observed that the repellent gave almost absolute protection from infection for 12 hours, while at 24 hours protection was manifested by markedly reduced worm burdens in the experimental animals. It appears therefore that despite differences in methods of testing, the repellent cream was almost equally effective in preventing infections with either *S. mansoni* or *S. japonicum*.

Bauman *et al.* (1955) attempted to determine the stability of the repellent cream on undisturbed skin for periods up to 6 hours. Protection during this time was complete. The mice were not restrained in any way beyond this time in either experiment, hence the decrease in protection after 6 hours was probably due to factors such as volatilization or other loss of active ingredients of the cream caused by the normal activities of the animals. The repellent cream did not appear to be irritating to the mice; nor did the mice seem to be attracted to the cream.

SUMMARY

Under conditions of laboratory experiments, topical applications of Abbott's Insect Repellent Cream (E4856) prevented infections with *Schistosoma japonicum* in mice for limited periods of time. Protection was not absolute in every instance; however, a significantly large number of experimental animals received complete protection if exposed to cercariae within 12 hours after application of the repellent. Mean worm burdens in mice exposed after 6, 12 and 24 hours were significantly lighter than those of the controls. The lighter worm burdens represented reductions of 97.8 to 87.9%. A low level of protection persisted to 30 hours; mice in two groups so tested exhibited worm burden reductions of 30.8 and 57.0 percent.

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PAN, C. AND HUNTER, G. W. III. 1951 A modified perfusion technique for the recovery of schistosomes. J. Lab. Clin. Med. **37**: 815–816.

RESEARCH NOTE

THE FRINGED TAPEWORM IN WISCONSIN

Autopsy of a moribund lamb from Dodge County, Wisconsin, in July 1955, revealed the presence of a large number of common tapeworms (*Moniezia expansa*) among which were found 3 small pieces of fringed tapeworm, *Thysanosoma actinioides*. The liver had been discarded by the time these fragments were found. Each piece seemed to be a single proglottid but no egg-cases could be detected within. It might be speculated that these fragments were ingested following their expulsion from an imported sheep, were it not for the fact that the pieces showed no signs of digestion and the delicate fimbriae were still intact. In view of present opinion regarding the nature of the cyclophyllidean tapeworm cuticle, proglottids would not be expected to survive passage through both the stomach and the duodenum. That the animal in question was infected with *Thysanosoma* is the only tenable conclusion. This worm was twice recovered by the senior author from sheep from Bayfield County, Wisconsin, in 1954, but in these instances the original source of the sheep was not established. The present report seems to be the first record of the fringed tapeworm in a native Wisconsin sheep.

Thysanosoma actinioides has long been regarded as a parasite peculiar to the western area of the United States. As recently as 1951 the Annual Report of the Chief of the Bureau of Animal Industry contained the statement that the fringed tapeworm "occurs only in the West," and Morgan and Hawkins (1949, Veterinary Helminthology. Burgess, Minneapolis. 400 pp.) defined the eastern limit as "North Dakota, South Dakota, Nebraska, Oklahoma, Texas." Since tapeworms often are transported eastward along with their hosts, the absence of infections in the native sheep in midwestern and eastern areas has generally been considered to indicate the absence of suitable intermediate hosts in the latter areas. On the other hand, the fringed tapeworm has been reported in native sheep in Minnesota (Goldsby, A. I. and D. F. Eveleth, 1944, Bimonthly Bulletin, North Dakota Agricultural Experiment Station 7, 35) and Todd, University of Wisconsin, recovered this parasite from a native Illinois sheep in 1952 (unpublished). Although there is no doubt that *Thysanosoma actinioides* is essentially a western parasite, these 3 records of infections east of the Missouri River, 2 of them east of the Mississippi River, serve to point out that it is not strictly confined to the West.—W. C. CAMPBELL AND A. C. TODD, *Department of Veterinary Science, University of Wisconsin, Madison, Wisconsin, Paper N.S.203. Published with the approval of the Director of the Wisconsin Agricultural Experiment Station and supported in part by the Research Committee of the Graduate School with funds from the Wisconsin Alumni Research Foundation, in part by Pittman-Robertson Project (W-15-R) of the Wisconsin Conservation Department.*

STUDIES ON THE HELMINTH FAUNA OF ALASKA. XXIX. *URINATREMA ASPINOSUM* N. SP. (TREMATODA: ZOOGONIDAE) FROM THE URINARY BLADDER OF THE GREENLING, *HEXAGRAMMOS SUPERCILIOSUS* (PALLAS)*

EVERETT L. SCHILLER**

During the autopsy of fishes collected at Amchitka, Aleutian Islands, Alaska, in the spring of 1952, several specimens of a new trematode belonging to the genus *Urinatrema* Yamaguti, 1934, were obtained from the urinary bladders of greenlings, *Hexagrammos superciliosus* (Pallas). These trematodes occurred in 9 of the 75 greenlings examined and the numbers of worms per infected fish ranged from 2 to 10. The specimens were fixed in alcohol-formalin-acetic acid solution and stained with Semichon's acetic carmine.

FAMILY ZOOGONIDAE

Urinatrema aspinosum n. sp.
(Fig. 1.)
(All measurements are in millimeters)

Diagnosis: Body smooth, flattened, and somewhat pear-shaped with bluntly pointed anterior and rounded posterior ends. Lateral margins of hindbody crenated. Length 3.23 to 6.0. Broadest at middle of posterior third of body, 1.66–3.23. Oral sucker 0.3 in diameter. Acetabulum in anterior third of body, 0.5 in diameter. Sucker-acetabulum size ratio approximately 1:1.6. Prepharynx absent; pharynx muscular, nearly spherical, 0.16 in diameter. Esophagus short, 0.099 in diameter and about 0.13 in length, bifurcating anterior to acetabulum. Voluminous ceca extend almost to posterior end of body. Excretory vesicle Y-shaped; excretory pore dorsoterminal. Genital atrium on left margin of forebody on level slightly posterior to bifurcation of ceca. Testes, 0.896 by 0.448, elongated, deeply indented, disposed symmetrically and extracecally in broadest part of hindbody. Curved cirrus sac extends from slightly posterior to margin of acetabulum to left margin of body. Vesicula seminalis long and somewhat sinuous. Metraterm located anterior and dorsal to cirrus sac. Lobate ovary, 0.415 by 0.265, situated dorsally in median line at level of juncture of fore- and hindbody. Vitelline follicles massed into nearly symmetrical groups extending laterally and ventrally to ceca, from level of middle of acetabulum posteriorad to ovarian zone. Uterus ventral to ceca, with transverse loops reaching inner margins of testes. Anterior part of uterus passes forward ventral to ovary and leads into metraterm. Eggs, in utero, thin-shelled, elongated oval, 0.034 to 0.038 by 0.015 to 0.019.

Host: *Hexagrammos superciliosus* (Pallas), greenling.

Habitat: Urinary bladder.

Locality: Constantine Harbor, Amchitka Island, Aleutian Islands, Alaska.

Type and paratype specimens: Deposited in the Helminthological Collection of the U. S. National Museum, No. 38124.

Variation: Considerable variation in the size of the body of this trematode was noted. Gravid specimens ranged in length from 3.23 to a maximum of 6.0. The size of the internal organs appeared to be roughly proportional to the length of the body. Variation in testis shape is also marked. The shape varies from slightly irregular to deeply indented.

Discussion: Urinatrema hispidum Yamaguti, 1934, recorded from the urinary bladder of *Hexagrammos otakii* Jordan et Starks, is the genotype and, heretofore,

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*Material collected while with the Zoonotic Disease Section, Arctic Health Research Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Anchorage, Alaska.

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the only known member of this genus. *Urinatrema aspinosum* differs in the absence of cuticular spination. According to Yamaguti's (1934) description of *U. hispidum*, "The cuticle is covered with strong sharp spines all over and presents a shaggy appearance; these spines, about 0.012 mm long, are particularly numerous and powerful in the anterior part of the body." Other morphological characters which serve to differentiate these species are indicated in Table I.

TABLE I.—*A comparison of some morphological characters of* Urinatrema hispidum *Yamaguti, 1934, and* U. aspinosum *n. sp.* (*All measurements in mm*)

	U. hispidum	*U. aspinosum*
Length	2.575 (range: 1.72–2.82)	5.56 (range: 3.23–6.0)
Width	1.33	1.87 (range: 1.66–3.32)
Diameter of oral sucker	0.3 (range: 0.18–0.25)	0.3
Diameter of acetabulum	0.325 (range: 0.2–0.33)	0.5
Sucker-acetabulum ratio	1 : 1.2	1 : 1.6
Testis size and shape	0.66 × 0.25 (right) 0.61 × 0.21 (left) longitudinally elongated; medially indented	0.896 × 0.448 (right) 0.863 × 0.448 (left) longitudinally elongated; irregular to deeply indented
Ovary size and shape	0.3 × 0.225 laterally indented	0.415 × 0.265 deeply lobed
Cirrus sac	extends from middle of acetabulum	extends from just below posterior margin of acetabulum
Egg size and shape	0.03–0.04 × 0.018–0.024 thin shelled; elongated oval	0.034–0.038 × 0.015–0.019 thin shelled; elongated oval
Cuticle	Covered with strong sharp spines; spines 0.012 in length	Aspinose

EXPLANATION OF PLATE

FIG. 1. Morphological details of *Urinatrema aspinosum* n. sp. (Ventral view). Scale has a value of 1 mm.

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OCCURRENCE OF *DIOCTOPHYMA RENALE* IN LOUISIANA, WITH REMARKS ON THE SIZE OF INFERTILE EGGS OF THIS SPECIES

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During a survey of parasites of south Louisiana fur-bearing mammals, carried out under a grant from the Louisiana Fisheries and Wildlife Commission, it was decided to include a study of the giant kidney worm (*Dioctophyma renale*) in the mink (*Mustela vison*). A cash reward was offered to the first trapper reporting and delivering a specimen of this helminth in the mink. Gross appearance of the worm and features of its pathogenesis were circulated through the Fur and Refuge Division of the Commission, and provisions were made for preservation of material in the field, as travel in the marshland during the trapping season is difficult.

Ehrenford and Snodgrass (1955) reported a total of 121 cases of *D. renale* in North America, together with 5 new cases from dogs in Indiana. These authors, together with Meyer and Whitter (1950), found that this parasite occurred in the District of Columbia, Arkansas, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Michigan, Minnesota, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia and Wisconsin and in Manitoba, Ontario and Quebec provinces of Canada.

In the present study 4 female and 1 male *D. renale* were recovered from 3 mink. One solitary female worm was found in a hollowed-out kidney containing a bony spicule like that described by Hallberg (1953). Due to its disintegrating, friable state this specimen was not measured. The mink from which the worm was recovered was trapped February 14, 1955 in the Vermillion Bay region. Three other female specimens were obtained from the peritoneal cavity of a second mink captured January 8, 1955 on Marsh Island Refuge, Louisiana. These measured 32.2, 31.0, and 23.5 cm in length respectively by 4.0 to 5.0 mm in diameter. Examination of the parasitized carcass showed no evidence of recent or earlier penetration into either kidney. The last specimen obtained was a single male worm in the peritoneal cavity of a mink captured March 2 on Marsh Island. This specimen measured 17.5 cm in length by 2.5 to 3.0 mm in diameter and, again, no damage to the host was evident.

In addition to the above specimens, one of us (E. C. F.) has in the Museum of Parasitic and Tropical Diseases of Tulane Medical School a single large female worm from the peritoneal cavity of a dog which he autopsied in New Orleans April 23, 1931.

Length and width measurements were done on 35 eggs from one of the female worms from the mink taken on Marsh Island Refuge, and the same number from preserved material from the dog. Eggs of the mink parasite ranged from 60 to 81 microns by 39 to 46 microns, with a mean of 68.7 by 42.4 microns, and those from the dog similarly ranged from 60 to 72 by 38 to 45 microns with a mean of 67.2 by 41.3 microns. Due to the absence of accompanying male worms in the mink and dog, we concluded that these were infertile eggs. Morgan and Hawkins (1949) gave the size range for *D. renale* eggs as 71 to 84 microns by 46 to 52 mi-

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crons. Christenson (1940) cited Balbiani's (1870) figures as 68 by 42 microns, Leuckart's (1876) as 64 by 44 microns, Blanchard's (1889) as 64 to 68 by 42 to 44 microns, and his own measurements of eggs from specimens recovered from dogs as 72 to 80 by 40 to 48 microns, with an average of 76.7 by 44.9 microns. He gave a size range of the eggs for specimens from mink of 64 to 76 microns by 36 to 44 microns, with a mean of 70.8 by 41.4 microns. Woodhead (1950) quoted unpublished work by McNeil, who found the average egg size to be 74.3 by 46.7 microns. These last figures are probably for fertile eggs of worms from the mink, whereas it is not stated in other sources mentioned as to whether the eggs were fertile or infertile. Thus it appears that there is a relatively wide range in egg size, particularly in length. This variation may result from differences in host species, but may also reflect the status of fertility or infertility of the female worm. Statistical comparison of known fertile and infertile eggs of this helminth may show significant differences. To our knowledge this study has not been made.

A further note of interest is that the place of capture of at least two of our three hosts was in a saline habitat, either marine or at least highly brackish. Marsh Island Refuge, located in Iberia parish, comprises 79,000 acres of marshland nearly at sea level. On the south it faces directly on the Gulf of Mexico, on the northwest is bordered by Vermillion Bay, and on the north and east by West Cote Blanche Bay. A channel separates it from Pecan Island on the west. The entire island is honeycombed with a series of salt-water tidal channels. According to Mr. Fred Webert, Biologist for the Fur and Refuge Division, the Island has very few if any crayfish; the predominant crustaceans are land crabs. The suspected second intermediate host in this region is the salt water catfish (*Galichthys felis*). No confirmatory work has been done thus far on the possible salt-water life cycle of this worm.

We extend our thanks to the Louisiana Fisheries and Wildlife Commission for funds supporting this study, and especially to Mr. Ted O'Neil and Mr. Fred Webert and others of the Fur and Refuge Division for their whole-hearted cooperation.

SUMMARY

Dioctophyma renale is reported for the first time from Louisiana. A solitary female was recovered from the hilus of a kidney of a mink (*Mustela vison*), 3 other female worms from the peritoneal cavity of a second mink and a solitary male from the peritoneal cavity of a third mink. These hosts were trapped in salt or brackish water in the Vermillion Bay area. An additional previously unpublished record from Louisiana is that of a female *D. renale* from the peritoneal cavity of a dog autopsied in New Orleans in 1931.

Measurement of presumably infertile eggs of *D. renale* from the Louisiana mink and dog vary widely, particularly in length. A statistical comparison of the average size of known infertile and fertile eggs might show significant differences.

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RESEARCH NOTE

A CURSORY SURVEY OF HUMAN INTESTINAL PARASITES IN THE NOMADIC PEOPLE OF SOUTHERN TURKEY

During the months of July and August 1954, a small group of investigators from the United States Naval Medical Research Unit No. 3 of Cairo, Egypt, visited southern and eastern Turkey for the purpose of conducting an entomological and parasitological survey of that relatively remote region.

Five days of the approximately 6 weeks in the field, were spent in the vicinity of Urfa, a city on the Belih river, one of the tributaries of the Euphrates. This region lies only 30 miles north of the Tell Abiad area of Syria, reported by Pipkin and Rizk (1949, Am. J. Hyg. **49**: 276–284) as being 1 of 2 foci of vesical schistosomiasis in northern Syria. Therefore, we were interested in making a necessarily brief survey to determine whether schistosomiasis was likewise endemic in this sector of southern Turkey. Although our primary interest was schistosomiasis, we were prompted to record the incidence of other parasites when a review of the literature revealed how very little is known regarding the human intestinal parasites of the region.

Urine and fecal specimens were obtained from the semi-nomadic males of mixed Kurdish and Arabic descent, inhabiting the arid country near Urfa. They ranged in age from 6 to 50 years. Women declined to submit specimens. Urine specimens from 224 individuals were collected in standard bottles and examined the same day with the aid of a hand centrifuge in our improvised field laboratory in Urfa. Upon receipt of the stool specimens from 118 individuals, a portion of the fresh fecal material was fixed by the MIF method (Sapero and Lawless, 1953, Am. J. Trop. Med. & Hyg. **2**: 613–619) and later examined employing the MIFC technic (Blagg *et al*, 1955, Am. J. Trop. Med. & Hyg. **4**: 23–28) in our laboratory at Cairo.

We were unable to demonstrate the eggs of *Schistosoma haematobium* in the sediment of the 224 urine specimens. On the other hand, only 4 of the 118 stool specimens were found completely negative for intestinal protozoa and helminths; protozoa were absent in 20 and helminth eggs in 8 specimens. Since these data are the result of single stool examinations, the prevalence of these parasites is undoubtedly greater.

Entamoeba histolytica was found in 9%, 4% with the large race and 5% with the small race. *E. coli* was the most common intestinal protozoan, being found in 68%. *Endolimax nana* and *I. bütschlii* were found in 12% and 16% respectively. *Chilomastix mesnili* and *Giardia lamblia* each occurred in 4%. Of the 4 species of helminths recorded, *Ancyclostoma duodenale* was found in only 4% of the stool specimens. *Ascaris lumbricoides* and *Trichuris trichiura* were found in 68% and 72% respectively. *Taenia* eggs were present in 20% of the stools; also, 6 specimens contained proglotids of *T. saginata*. It is unlikely that *T. solium* would be present, since these Muslim people do not eat or raise pork. Our failure to find *Trichostrongylus* is rather surprising, since these people associate closely with animals such as the camel and other herbivores.

I am grateful to Wilson Blagg and Noshy S. Mansour, NAMRU 3, Cairo, Egypt, for technical assistance in the examination of the fecal specimens.—WILLIAM H. WELLS, *Department of Parasitology, U. S. Naval Medical Research Unit No. 3, Cairo, Egypt. Present Address: U. S. Naval Hospital, Oakland, California.*

TREMATODES OF MARINE FISHES OF MEXICAN WATERS IX. FOUR GASTEROSTOMES FROM THE PACIFIC COAST*

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The trematodes reported herein were collected by the senior author from marine fishes from Zihuatanejo, Mazatlán and Puerto Vallarta, on the Pacific coast of Mexico.

Acknowledgments are extended to Miss Guadalupe Monsvais for aid in collection of hosts and material, and to Dr. H. W. Manter for advice and reading of the manuscript. All measurements are in mms.

FAMILY BUCEPHALIDAE

Bucephalus heterotentaculatus n. sp.
(Figs. 1, 2, 3)

Host: *Scomberomorus sierra* Jordan and Starks, sierra
Location: Intestine.
Locality: Zihuatanejo, Guerrero, Pacific Coast of Mexico.
Holotype: U. S. Nat. Mus. Helm. Coll. No. 38120.
Paratype: Biol. Inst., Univ. of Mexico No. 214-11.

Diagnosis (Based on 6 specimens, measurements on 4): *Bucephalus:* Body 2.08 to 3.42 long by 0.26 to 0.42 wide; elongate, cylindrical, blunt at anterior end, tapering at posterior end and rounded at posterior extremity. Cuticle with small scale-like spines. Anterior sucker 0.22 to 0.28 long by 0.22 to 0.26 wide; with 7 tentacles. Tentacles 1 and 7 ventral, (tentacles numbered from left side to right side of body, see Fig. 2) each with a pair of lateral basal projections; tentacles 2 and 6 dorsal, each with 3 basal projections; tentacles 3 and 5 dorsal, each with one lateral basal projection; tentacle 4 dorsal, with a pair of lateral basal projections. Dorsal tentacles difficult to observe due to their contracted state. Mouth 1.62 to 1.92 from anterior end of body; posterior to mid-body level. Pharynx 0.075 to 0.094 long by 0.078 to 0.1 wide, usually wider than long, between ovary and anterior testis in posterior half of body although in one specimen pharynx touches posterior testis. Intestine 0.31 to 0.414 long by 0.12 to 0.207 wide; anteriorly directed; anterior to ovary close to its anterior border, but may overlap ovary. In one specimen, esophagus measured 0.172. Genital pore subterminal. Cirrus sac. 0.641 to 0.86 long by 0.117 to 0.14 wide, sinistral, reaching anterior edge of anterior testis in contracted specimens and to posterior end of posterior testis in extended specimens. Cirrus sac-length to body-length ratio 1 : 2.94 to 1 : 3.78. Internal seminal vesicle approximately 1/4 length of cirrus sac. Prostate gland cells surround seminal duct. Genital atrium 0.172 to 0.303 long by 0.094 to 0.165 wide; with 3 lobes, middle longest. Ratio of length of genital atrium to total lengths of cirrus sac and genital atrium from 1 : 3.74 to 1 : 4.37. Testes tandem, in third fourth of body, dextral, postovarian, usually longer than wide. Ovary dextral; close to, or in contact with anterior edge of anterior testis; slightly anterior to or level with pharynx. Vitellaria composed of round follicles; in two lateral rows beginning about 1/3 body length from anterior end; sinistral row with from 12 to 15 follicles, extending to anterior edge of anterior testis; dextral row with from 14 to 20 follicles, extending to mid-ovary. Uterus in short transverse, ascending and descending coils; extending anteriorly past vitellaria. Eggs operculated, thick shelled, embryonated, 22 to 28 microns long by 13 to 17 microns wide. Excretory vesicle extending to near anterior sucker.

The name *heterotentaculatus* indicates the heterogeneous condition of the tentacles.

Discussion: The actual number of tentacles was difficult to observe because the tentacular projections sometimes appeared to be tentacles, and because of varying degree of contraction. Once the tentacles were understood, and considering their position and degree of contraction, they were found to agree in all specimens.

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** Guggenheim Scholar at the Zoology Department, University of Nebraska, 1956.

The species is unusual in having three varieties of tentacles differing in the number of basal projections present.

Thirty species have been named in the genus *Bucephalus*. *B. heterotentaculatus* differs from all of these in details of its tentacles. It differs from *B. scorpaenae* Manter, 1940 in its anteriorly directed intestine, in more posterior extent of vitellaria, more anterior extent of excretory vesicle, and in three (rather than two) atrial lobes. It differs from *B. sphyraenae* Yamaguti, 1952 chiefly in having tentacles with projections; other small differences are more anterior extent of excretory vesicle, and its three atrial lobes. It differs from *B. uranoscopi* Yamaguti, 1934 in that the uterus extends anterior to the vitellaria, the cirrus sac is about 1/3 body length (as compared with 1/6), and larger eggs.

Bucephalus introversus Manter, 1940

Host: Citula dorsalis (Gill)
Location: Intestine and body cavity.
Locality: Mazatlán, Pacific Coast of Mexico.
Museum Specimens: U. S. Nat. Mus. Helm. Coll. No. 38122. Biol. Inst., Univ. of Mexico No. 214-12.

Discussion: Manter (1940) described *Bucephalus introversus* from carangid fishes of the genera *Seriola* and *Caranx* from Colombia and Mexico. He found *B. introversus* in the stomach, once on the gills, but never in the intestine. The mexican *B. introversus* reported in this paper were always found in the intestine of *Citula dorsalis*. *Citula dorsalis* is a small carangid fish and may well serve as food for larger carangids such as *Caranx* and *Seriola*. The distribution of *Citula dorsalis* is from Mazatlán to Panama and probably Colombia. Manter's (1940) sites of collection of *B. introversus* correspond closely with the distribution of *Citula dorsalis*. Since the intestine is the usual habitat for species of *Bucephalus*, the normal host for *B. introversus* is probably *Citula dorsalis*. The specimens taken from the stomach of *Caranx* and *Seriola* by Manter (1940) may have been accidental in these fishes.

Bucephalus varicus Manter, 1940

Host: Caranx hippos Linn.
Location: Intestine.
Locality: Puerto Vallarta, Jalisco, Pacific Coast of Mexico.
Museum Specimens: U. S. Nat. Mus. Helm. Coll. No. 38121. Biol. Inst., Univ. of Mexico No. 214-13.

Discussion: Manter (1940) named *Bucephalus varicus* for specimens from *Caranx* sp. at Bahia Honda, Panama. He considered the *Bucephalus polymorphus* Baer, 1827 of Nagaty (1937) to be a synonym of *B. varicus*. Reasons for considering *B. varicus* distinct from *B. polymorphus* Baer, 1827 were: (1) The cirrus sac is longer; (2) the ovary is pretesticular, rather than lateral to anterior testis; and (3) *B. varicus* is from marine hosts. Our specimens have smaller eggs than those described by Eckman (1932) for *B. polymorphus* (17 to 20 by 12 to 14 microns as compared with 26 by 15 microns for *B. polymorphus*).

Manter (1955) has noted marine trematode faunal similarities between the regions of Japan, Red Sea, Gulf of Mexico, and the Tropical Pacific. *B. varicus* apparently occurs in Carangids in all these localities.

Bucephaloides cybii (Park, 1939) Hopkins, 1954

Host: *Sarda orientalis* Temn. and Sch. and *Scomberomorus* sp.
Location: Pyloric ceca and intestine.
Locality: Manzanillo, Colima, Pacific Coast of Mexico.
Museum Specimens: U. S. Nat. Mus. Helm. Coll. No. 38123. Biol. Inst., Univ. of Mexico No. 214-14.

Discussion: Park (1939) described *Bucephalopsis cybii* from *Cybium orientalis* and five "gobies" from Simmi Island of North Tyosen, Korea. The specimens of *B. cybii* Park, 1939 from *Sarda orientalis* and *Scomberomorus* sp. from Mexico agree, with one exception, in every respect with the description of *B. cybii.* There are 3 papillae on each side of the genital atrium aperture which are especially visible when the genital lobes are extruded from the body (Fig. 4). Park may have overlooked these papillae in his description of *B. cybii.*

Hopkins (1954) restricted the generic name *Bucephalopsis* to a cercaria, *B. haimeanus* Lacaze-Duthiers, 1854, the adult of which is unknown. He named the genus *Bucephaloides* for all other species formerly included in the genus *Bucephalopsis. Bucephalopsis cybii* Park, 1939 became *Bucephaloides cybii* (Park, 1939) Hopkins, 1954.

SUMMARY

1. Four species in two genera of the family Bucephalidae are reported from the Pacific Coast of Mexico.

2. A new species, *Bucephalus heterotentaculatus* is described from *Scomberomorus sierra* from Zihuatanejo, Guerrero, Pacific Coast of Mexico.

3. New host records are, *Bucephalus introversus* Manter, 1940 from *Citula dorsalis* from Mazatlán, Pacific Coast of Mexico; and *Bucephaloides cybii* (Park, 1939) Hopkins, 1954 from *Sarda orientalis* and *Scomberomorus* sp. from Manzanillo, Pacific Coast of Mexico.

4. New locality records are, *Bucephalus varicus* Manter, 1940 reported for the first time from the Pacific Coast of Mexico; *Bucephaloides cybii* (Park, 1939) Hopkins, 1954 is reported for the first time from the Western Hemisphere.

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EXPLANATION OF PLATE

All figures were drawn with the aid of a camera lucida unless otherwise specified. The projected scale has value in millimeters indicated in each figure.

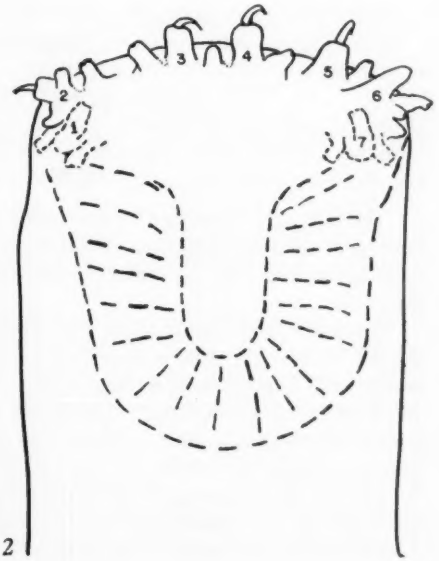
FIG. 1. Dorsal view of *Bucephalus heterotentaculatus.*

FIG. 2. Composite diagram. Dorsal view of anterior sucker of *B. heterotentaculatus.*

FIG. 3. Dorsal view of cirrus sac and genital atrium of *B. heterotentaculatus.*

FIG. 4. Lateral view of cirrus sac and genital atrium of *Bucephaloides cybii* (Park, 1939) Hopkins, 1954.

1



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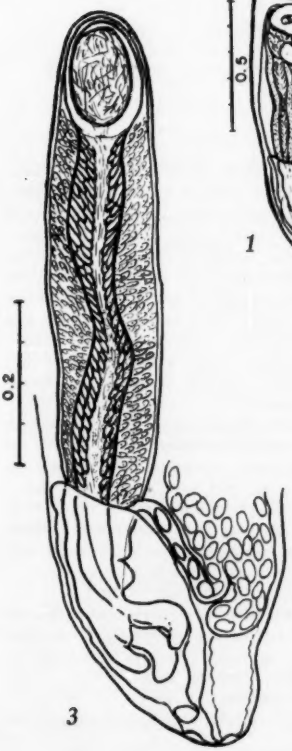

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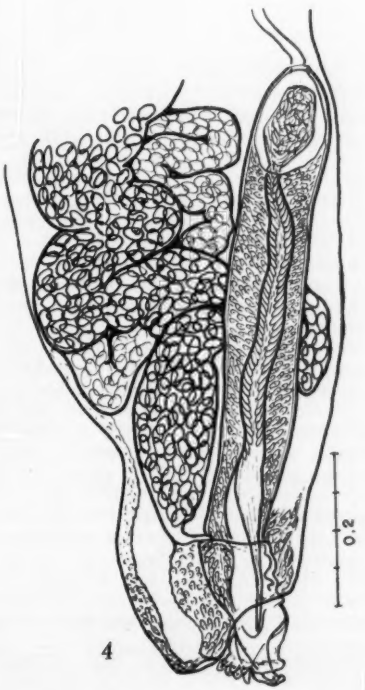

4

MORPHOLOGY OF *ASCOCOTYLE LEIGHI*, N. SP. (HETEROPHYIDAE), AN AVIAN TREMATODE WITH METACERCARIA RESTRICTED TO THE CONUS ARTERIOSUS OF THE FISH, *MOLLIENESIA LATIPINNA* LE SUEUR

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The trematode described in this paper was first observed as a metacercaria encysting in the conus arteriosus of *Mollienesia latipinna* Le Sueur. The incidence of infection was very high, and the metacercariae showed a definite specificity for the conus.

A search for the natural host was without success, and as a result, the description of *Ascocotyle leighi* is based on adults recovered from day-old unfed chicks which were infected with metacercariae. Infections of 28 chicks were attempted, 16 of which were successful. The adults undergo a transient development in the posterior part of the small intestine, reaching the egg-producing, but not the egg-liberating stage, after 66 to 72 hours of incubation. Shortly thereafter their numbers progressively diminish, no adults being recovered after 119 hours of incubation. Attempts to infect mice with the metacercariae were unsuccessful.

This trematode is named in recognition of Dr. W. Henry Leigh of the University of Miami Zoology Department.

Ascocotyle leighi, n. sp.

(All measurements in millimeters; 10 specimens, 72 hours or older, were measured)

Diagnosis: with characters of the genus. Small distome. Body pyriform, concave ventrally, 0.283 to 0.402 (av. 0.339) long by 0.084 to 0.122 (av. 0.099) wide at level of acetabulum. Anterior end 0.038 to 0.059 (av. 0.050) wide at level of lateral expansions of oral sucker and exhibiting an anterior lip-like projection. Cuticula entirely scaly-spinose. Unevenly distributed pigment granules, probably remnants of cercarial eyespots, persisting dorsally in regions lateral to pharynx. Oral aperture terminal and surrounded by double row of 48 to 52 spines (24 to 26 in each row) directed posteriorly, those of anterior row 0.012 to 0.014 (av. 0.013) long and those of posterior row 0.009 to 0.011 (av. 0.010) long. Oral sucker elongate and conical, with posterior muscular projection which is often contracted into an "S" shape; acetabulum 0.031 to 0.042 (av. 0.036) in diameter, slightly post-equatorial, and retractable into ventro-genital sinus. Prepharynx 0.035 to 0.105 (av. 0.073) long, slender, ventral to posterior projection of oral sucker; pharynx 0.028 to 0.035 (av. 0.032) long by 0.021 to 0.028 (av. 0.023) wide; esophagus very short; intestinal ceca short and expanded, terminating just anterior to acetabulum. Ventro-genital sinus median, with single preacetabular gonotyl lying to left of median line. Seminal vesicle large and located left, slightly curved, extending transversely on level with anterior margin of ovary and tapering toward ovarian end into ejaculatory duct; ejaculatory duct turns abruptly left and arcs around left side of acetabulum to point near gonotyl, where it joins with metraterm to form common duct opening into ventro-genital sinus through genital pore between gonotyl and acetabulum. Testes spherical to ovoid, side by side at posterior end of body, 0.036 to 0.049 (av. 0.042) in diameter, and usually in contact with each other. Ovary spherical, 0.021 to 0.028 (av. 0.026) in diameter, anterior to, and in proximity of, right testis. Seminal receptacle spherical and median, although sometimes displaced slightly left, on level with posterior margin of ovary. Vitellaria lateral, extending from near posterior end of body to level of aperture of acetabulum. Uterus extending into posttesticular region, joining with ejaculatory duct dorsal to gonotyl to form common genital duct. Eggs 0.016 to 0.018 (av. 0.017) long by 0.009 to 0.011 (av. 0.010) wide.

Received for publication June 12, 1956.

Experimental host: Day-old chicks. Natural host unknown, probably piscivorous birds.
Location: Posterior region of small intestine.
Distribution: South Florida.
Cotypes: U.S.N.M. Helm. Coll. No. 38161.

DISCUSSION

Seven species of the genus *Ascocotyle* (s. str.) have been described previously. Price (1935) revised the *Ascocotyle-Phagicola* complex, and restricted the genus *Ascocotyle* to forms exhibiting a double row of oral spines, an entirely spinous cuticula, a uterus extending anteriorly to the genital aperture, and the vitellaria extending anteriorly to the level of the ovary. He later (1936) invalidated the extent of the uterus as a constant differentiating character, and offered a key to the genus *Ascocotyle* (s. str.).

Ascocotyle leighi may be readily differentiated from all other members of the genus by the number of spines in the oral coronet. *A. tenuicollis* Price, 1935, and *A. puertoricensis* Price, 1935, are the two species most closely resembling *A. leighi*, but may be separated on the basis of the number of spines in the oral coronet and the respective positions of the seminal vesicles. Both *A. tenuicollis* and *A. puertoricensis* have a total of 32 spines in their oral coronets (16 in each of 2 rows). This contrasts with a total of 48 to 52 spines in the coronet of *A. leighi* (24 to 26 in each of 2 rows). The seminal vesicles of *A. tenuicollis* and *A. puertoricensis* taper anteriorly from a bulb-like expansion. In *A. leighi* the vesicle lies on a transverse plane and tapers medially toward the ovary.

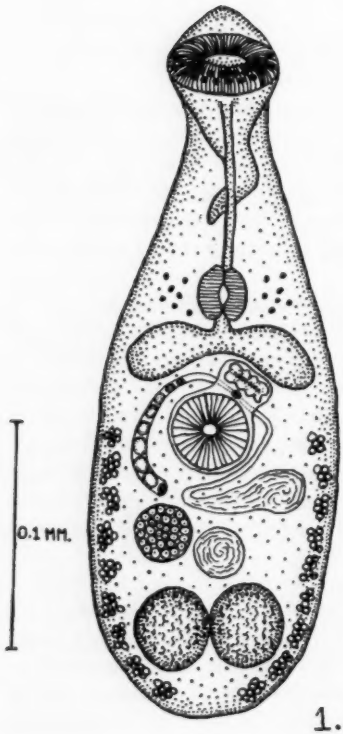
Examinations of piscivorous birds frequenting the area of collection failed to reveal the normal host, even though other species of *Ascocotyle* were often encountered. Two green herons, *Butorides virescens virescens* (Linnaeus), 1 black-crowned night heron, *Nycticorax nycticorax hoactli* (Gmelin), 4 little blue herons, *Florida caerulea caerulea* (Linnaeus), 6 Louisiana herons, *Hydranassa tricolor ruficollis* (Gosse), 1 great blue heron, *Ardea herodias* Linnaeus, and 1 cormorant, *Phalacrocorax auritus* (Lesson), were examined.

A total of 341 *Mollienesia latipinna* were examined and only 12 were devoid of infection. The metacercariae were not observed in any part of the host anatomy other than the conus arteriosus, and as many as 30 or 35 cysts were frequently recovered from a single conus. Specificity of the metacercariae for *Mollienesia* seemed apparent, for examinations of other small fishes in the area of collection proved negative.

Sections through the conus of infected *Mollienesia* showed that the metacercariae encyst in the wall immediately under the endothelium. Growth of the metacercariae toward the lumen results in occlusion of the vessel to the point of possible interference of arterial blood flow.

The conus of another small fish, *Gambusia affinis holbrooki* (Girard), was often found infected with a different species of *Ascocotyle*, probably *A. tenuicollis* Price, 1935, for it resembled this form in general morphology and in the number of oral spines (16 in each of 2 rows). The cysts of this type are large and ovoid, as contrasted to the smaller, spherical cysts of *A. leighi*. The coni of *Gambusia* are infected with smaller numbers of metacercariae (usually less than 10) than are those of *Mollienesia*, and of 53 *Gambusia* examined, only 23 were found infected. The *Gambusia* type of cyst apparently does not show the host specificity of *A. leighi*,

PLATE I



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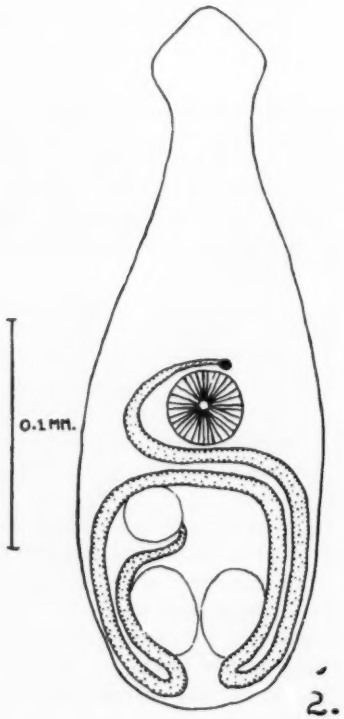

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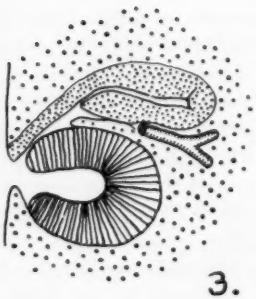

3.

for small numbers of these cysts were frequently recovered from *Mollienesia* coni along with those of *A. leighi*.

The completion of the life history of *A. leighi* is to be undertaken by others in the near future.

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Explanation of Figures

(Figures 1 and 2 drawn with the aid of the camera lucida)

Figure 1. *Ascocotyle leighi* in ventral view.

Figure 2. Uterus pattern of *A. leighi* adult.

Figure 3. Lateral view of ventro-genital sinus showing relationship of gonotyl, genital pore, and common genital duct.

RESEARCH NOTE

A THREE-YEAR SURVEY OF *ORNITHOFILARIA* SP. MICROFILARIAE IN CANADA GEESE

In a survey of blood parasites of Canada geese, *Branta canadensis interior*, wintering at the Horseshoe Lake Game Refuge, Illinois, in November 1950, 2 species of microfilariae were found by Levine and Hanson (1953, J. Wildlife Mgt. **17:** 185–196). These microfilariae were later identified (Hanson, Levine and Kantor, 1956, J. Wildlife Mgt. **20:** 89–92). A long form, *Sarconema eurycerca*, 323–341 microns in length, was found in yearling geese, 5–8 months of age. The adults were found in the heart muscle. Larvae of a short form, *Ornithofilariae* sp., 50–82 microns in length, were found in immature geese as well as in older geese. Adults were not found. This later species may be *O. fallisensis*, found in the subcutaneous tissue of white pekin ducks in Algonquin Park, Ontario by Anderson (1954, Canad. J. Zool. **32:** 125–137). The results of a 3-year survey of *Ornithofilaria* sp. in immature Canada geese at Horseshoe Lake, Illinois, by the wet smear technique are presented in Table 1.

Table 1.—*Number of immature Canada geese examined and per cent found infected with* Ornithofilaria *sp. microfilariae, at Horseshoe Lake Game Refuge, Alexander County Illinois, 1953–56*

Year	Inclusive dates	Number examined	Per cent positive
1953–54*	Nov. 2–Feb. 13	153	28.8
1954–55	Nov. 18–Feb. 3	106	18.9
1955–56	Jan. 10–Feb. 2	110	22.8
Total or Weighted average		369	23.8

* Data from Hanson, Levine and Kantor, 1956.

From data at hand, it would appear that infection rates of *Ornithofilaria* sp. in immature Canada geese vary annually between 19 and 29 per cent. Studies are now needed to determine what harmful effects this species, as well as *Sarconema curycerca*, may have on the health of infected birds. Information is also needed from the Hudson-James Bay breeding grounds (Hanson and Smith, 1950, Ill. Nat. Hist. Surv. Bull. **25:** 67–210) to determine at what age most geese are infected, and whether infections are more prevalent in some parts of the breeding grounds than others.—Harold C. Hanson, *Illinois Natural History Survey, Urbana, Illinois.*

TISSUE DAMAGE IN SALMONIDS CAUSED BY *HALISIDOTA ARGENTATA* PACKARD

E. M. Wood and W. T. Yasutake

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During the histological examination of a collection of wild and hatchery salmonids, a peculiar foreign body was occasionally observed in various organs, particularly in the viscera. These objects, usually accompanied by a focal inflammation, were observed in 10 of 75 samples of wild trout and salmon collected in Oregon and Washington and were believed to represent an unknown type of parasitism. Their identity remained obscure until a massive concentration was observed in the tissues of wild coho salmon, (*Oncorhynchus kisutch*), from Minter Creek on the Olympic peninsula of Washington and in hatchery coho salmon from the Minter Creek Biological Station. The distribution of the structures suggested the intestinal tract as a point of origin. Subsequent stomach examinations revealed small, partially digested insect fragments with many long, spine-covered hairs. The insects were identified as second or third instars of the lepidopteran larvae, *Halisidota argentata* Packard. The spine-covered hairs penetrated the stomach wall and produced the observed lesions by working in an apparent porcupine quill-fashion throughout the body of the fish.

The pathology of the Minter Creek salmon was sufficiently extensive to merit a description of the condition for the benefit of other workers who may encounter this rather unusual phenomenon and confuse it with an actual parasitic infection.

MATERIAL

Personnel of the Washington Department of Fisheries at the Minter Creek Biological Station collected the samples of wild and hatchery fish. These fish were fingerling salmon which had been feeding for 3 to 6 months. The samples were fixed in Bouin's solution for 24 hours and stored in 65% alcohol. Routine paraffin sections and hematoxylin and eosin staining techniques were utilized in preparing the material for examination.

PATHOLOGY

Gross:

When the abdomens of affected fish were opened and the viscera examined under a dissecting microscope, the larval hairs appeared as fine, brownish to yellow lines scattered throughout the viscera. Frequently large numbers of hairs were observed projecting radially from the outside wall of the stomach. When the stomachs were opened, it was usual to see a great many hairs penetrating the mucosa from which they could not be removed due to the spiny processes.

Microscopic:

In hematoxylin and eosin sections, the hairs appeared as bright-yellow refractile foreign bodies surrounded by a narrow zone of inflammation. They were hollow structures without cellular detail. The inflammation was of a chronic type, usually consisting of small giant cells and monocytes. The inflammatory reaction was limited to the area immediately surrounding each individual shaft.

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However, there were frequently many hairs lodged in the visceral tissues and intense generalized inflammatory lesions resulted. This was particularly true in the adipose and pancreatic tissues among the gastric ceca. The spleen, which is usually located near the greater curvature of the stomach, was also punctured by multiple hairs. In various fish, however, almost every tissue was occasionally pierced by at least a single shaft. The liver, kidneys, auricle of the heart, spinal cord, and musculature were all observed with lesions. In some instances, hairs were observed just under the dorsal epithelium, having traversed the entire body musculature of the fish.

The hairs varied greatly in size with an approximate average diameter of 10 microns and extended to several millimeters in length. The spines angled away from the butt of the hair toward the tip and thus required a butt-first entry into the stomach mucosa.

DISCUSSION

The literature records few, if any, examples of animal pathology of this type. It is probable that the incidence among wild fish is usually low, but in the occurrence described at Minter Creek a heavy concentration of the larvae was unquestionably present. In addition, the presence of similar hairs in over 10% of 75 wild samples indicates that the potential source of the injurious hairs is quite widespread. The hairs have been observed in cutthroat trout, (*Salmo clarki*), brook trout, (*Salvelinus fontinalis*), rainbow and steelhead trout, (*Salmo gairdneri*), brown trout, (*Salmo trutta*) and coho salmon. The larvae apparently are only rarely available to hatchery fish since they were observed only once in 75 samples.

Our material does not permit a quantitative evaluation of the tissue damage. However, the intense concentration of these structures in many fish, and the occasional penetration of vital organs makes it highly probable that some mortality is a direct result of the hair penetration.

SUMMARY

Marked tissue damage was observed in young fingerling salmon from the Minter Creek Biological Station. The lesions were caused by plumose hairs from the larvae of *Halisidota argentata* Packard which penetrated the stomach and pierced the visceral organs and tissues of the fish. Similar hairs were observed in 10 of 75 samples of wild trout and salmon.

ACKNOWLEDGEMENTS

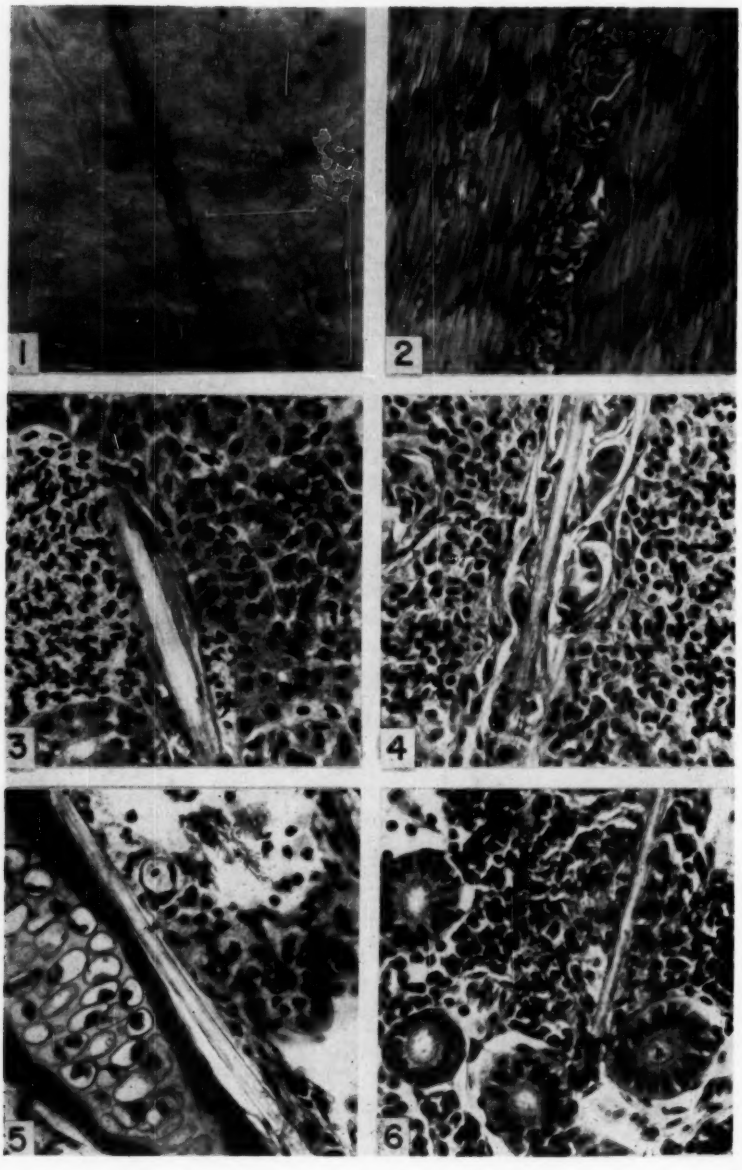
We wish to thank Dr. Julius Rudinsky and Mr. John D. Lattin, Department of Entomology, Oregon State College for identifying the insect fragments, and Mr. Richard E. Noble, Washington Department of Fisheries, for collecting the fish samples from Minter Creek.

EXPLANATION OF PLATE

(All figures ×400)

FIGURE 1. A wet mount of a hair lodged in the mesentery.
FIGURE 2. An inflammatory zone surrounding a hair in the wall of the stomach.
FIGURE 3. A hair lodged in the liver.
FIGURE 4. A hair lodged in the spleen.
FIGURE 5. This hair pierced the vertebral column and is adjacent to a vertebra.
FIGURE 6. A hair lodged in the kidney.

PLATE I



OBSERVATIONS ON *SHIPLEYA INERMIS* FUHRMANN, 1908 (CESTODA: ACOLEIDAE)

MARIETTA VOGE AND ROBERT RAUSCH

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Shipleya inermis, described by Fuhrmann (1908) and redescribed by Baer (1940), is known from only few specimens. The first and only North American record of this species was published by Webster (1951), who reported the finding of 2 specimens in dowitchers. Examination of a large number of cestodes from dowitchers collected by one of us (Rausch), and of cestodes from the Helminthological Collection of the United States National Museum yielded specimens which are without doubt *Shipleya inermis.* However, some of our observations which are reported here do not agree with Baer's description. In particular, we are unable to agree with Baer (1940) that individuals of *S. inermis* are hermaphroditic.

We are grateful to Mr. Allen McIntosh, Zoological Division, Beltsville, Maryland, for the loan of cestodes from dowitchers; and to Dr. F. N. Hamerstrom, Plainfield, Wisconsin, who collected the dowitcher from Iowa.

MATERIALS AND METHODS

The cestodes on which our study is based were obtained from 7 specimens of dowitcher, *Limnodromus* spp.* as follows: U. S. N. M. Helm. Coll. No. 48930 from La Jolla, California, April, 1947 (1 cestode); U. S. N. M. Helm. Coll. No. 48953 from the same locality, March 1935 (2 cestodes); No. R1, from Bono, Lucas Co., Ohio, August, 1944 (1 cestode); No. R3, Ruthven, Iowa, July 1934 (2 cestodes); No. R014550 from 12 miles south Anchorage, Alaska, May 17, 1955 (2 cestodes); No. R3A from Tulugak Lake, Brooks Range, Alaska, May 31, 1949 (1 cestode); No. R2A from Tulugak Lake, Brooks Range, Alaska, May 31, 1949 (2 cestodes).

Formalin or AFA was used for fixation. The cestodes were in excellent state of preservation. They were stained as whole mounts with carmine or hematoxylin stains. Thick sections were stained with Ehrlich's hematoxylin. It should be stressed that all our specimens were sufficiently well stained to eliminate the possibility of incomplete observation.

DESCRIPTION OF SPECIMENS

In view of the controversial question regarding the location of male and female gonads in *Shipleya inermis,* it seemed desirable to describe separately the specimens obtained from each individual host.

Received for publication, June 25, 1956.

* According to Pitelka (1950), 2 species of *Limnodromus* occur in North America, viz., *L. griseus* (Gmelin) and *L. scolopaceus* Say. The birds utilized in this work were collected mainly during migration, and both species were probably represented. Since the birds were not preserved for study, specific determinations were not made.

Host No. R2A contained 2 cestodes. One unbroken strobilar fragment 5 cm long and 2.3 mm in greatest width, containing only female gonads in mature proglottids (Fig. 1) followed by semi-gravid and gravid proglottids. For practical purposes the term "vagina" will be used to designate the organ in female strobilae which closely resembles the cirrus pouch and cirrus in male specimens. Vagina length is 765 microns in mature, and as much as 850 microns in gravid proglottids. The second specimen, a continuous strobila 1.9 cm long, measured 2.6 mm in greatest width, and consists of a scolex which had been deeply imbedded in the intestinal mucosa, and the strobila. Early immature proglottids contain the primordia of the cirrus pouch only. These are followed by segments which contain, in addition, a central primordium which eventually gives rise to a central mass of follicles. At this stage, the cirrus pouch is up to 850 microns long. No other gonadal structures are seen. Posterior to the region of clearly distinguishable follicles the proglottids increase in size and contain a central mass of fine granules which are the remnant of the follicular structures (Fig. 4). The granules eventually disappear. No trace of a uterus or of primordia of female gonads can be seen. Cirrus pouch length in these segments is as much as 900 microns. In all proglottids of this specimen, excepting the immature region, the cirrus pouch extends to the mid-line of the segment. This is not so in the specimen containing the female gonads.

No. 48953 also contained 2 cestodes. One of these is a fragment 1.8 cm long, containing the early immature and the mature region. Fully mature proglottids contain the female gonads. In early immature proglottids one observes the longitudinal excretory ducts and the primordia of the vagina. In mature proglottids 1.2 mm wide the vagina is 380 microns long. No testes are seen in this specimen. The second cestode is 3 cm long and about 1 mm in greatest width. The scolex (Fig. 3) is 1.2 mm wide and continuous with the remainder of the strobila. Sucker diameter is 272–300 microns. Immature proglottids contain primordia of the cirrus pouch and more posteriorly a central mass which resolves into a group of closely approximated follicles. At this stage, proglottids are about 1 mm wide and contain a fully developed cirrus pouch 552–640 microns long, extending beyond the mid-line of the segments (Fig. 2). Proglottids of similar size in the female strobila described above appear completely undifferentiated, except for excretory and muscular systems.

Host No. R3 contained 2 cestodes: One whole worm 6 cm long with a greatest width of 5 mm (contracted segments) and a scolex 1.37 mm wide, with suckers 357 microns in diameter. Immature proglottids contain the primordia of the female gonads and are followed by mature proglottids with well developed female gonads. The gravid segments contain the uterus and the vagina which is as much as 850 microns in length. Testes are not present in this specimen. The second cestode without scolex is 1.9 cm long. A central mass of follicles is present in anterior proglottids. In the posterior third of this strobila the follicles gradually disintegrate and eventually disappear. No primordia or traces of female gonads are seen in this specimen. The cirrus pouch extends to the mid-line of each segment and attains a length of 850 microns in the region where the follicles have disappeared.

No. 014550 contained a strobilar fragment including immature and mature regions. Mature proglottids contain a central mass of follicles and the cirrus pouch extends to the mid-line of the segment. No other gonadal structures are present. A second fragment comprising immature and mature proglottids contains female gonads only.

No. R3A contained one cestode. The strobila is 7 cm long and 4.5 mm in greatest width (contracted segments). Only female gonads are observed. The vagina attains a length of 680 microns in semi-gravid proglottids.

U.S.N.M. 48930 contained a fragment 1.5 cm long with early immature proglottids, mature proglottids with a central mass of follicles and a cirrus pouch, followed by segments in which the follicles had disappeared. No trace of female gonads was seen.

Host No. R1 contained 1 intact cestode 8 cm long and 3.5 mm in greatest width, with a scolex diameter of 900 microns and a sucker diameter of 250 microns. The primordia of the female gonads are seen about 1.5 mm posterior to the scolex. No testes are present. Mature proglottids contain the female gonads. In semi-gravid proglottids, vagina length is 640 microns. Onchosphere diameter in gravid proglottids is 30–34 × 38–40 microns.

DISCUSSION

Every segment of our material was carefully examined for the presence of both male and female gonads. From our observations we are convinced that our specimens represent entirely male or entirely female individuals of the same species of cestode. That this species is indeed *Shipleya inermis* Fuhrmann, 1908, is an as-

sumption based on the close agreement of our observations with the original description and, with the exception of testis location, to Baer's description (1940).

When Fuhrmann (1908) described *Shipleya inermis* from *Galinago gigantea*, his diagnosis of the genus was as follows (authors' translation):

"Acoleinae with scolex lacking rostellum or hooks. Male genital pores alternating regularly. The conical penis armed with large hooks. Vitelline gland dorsal to ovary. The only remnant of the vagina is a small seminal receptacle near the female gonad. Uterus at first ringshaped, very much ramified." Fuhrmann states (p. 72) that the testes were not seen and that they must occur without doubt in the early segments and then quickly disappear. He further states (p. 73) that the finer structure of the ovary could not be studied because of the state of preservation of the specimen. Baer (1940) also comments on the poor preservation of the original types. In young proglottids, the uterus is ring-shaped as in *Gyrocoelia* (Fuhrmann, p. 73). However, Fuhrmann's figure (p. 71) shows that the uterus does not form a complete ring.

Baer (1940) describes "several specimens" from *Capella delicata* as *Shipleya inermis*. He does not state whether or not his specimens were fragmented. His description does not include strobilar or scolex size. While Fuhrmann did not see the testes in his material, Baer describes 20–25 testes closely packed near the median end of the cirrus pouch. Our observations are in agreement with this statement. However, with regard to the position of the testes in the strobila, he states (p. 180): "The internal anatomy of this worm is peculiar in many ways and especially in that the anterior part of the strobila is entirely male, no female glands being visible although the uterus and receptaculum seminis are present." His figure 17 (p. 181) shows a transverse section of a male segment containing the cirrus pouch and testes as well as a structure labelled as receptaculum seminis. The uterus is not shown.

It appears that Baer was dealing with a species very much like *Shipleya inermis* but hermaphroditic, which is unlikely, or that his specimens were fragmented so that the sequence of development within the strobila could not be determined with accuracy. The male specimens studied by us are much shorter than the female specimens, and the male mature proglottids are as a rule smaller. This may lead to the belief that one is dealing with anterior portions of a strobila which subsequently contains the female gonads. Baer also states that "the testes have completely disappeared in the segments in which the female genitalia are formed." We have examined several intact specimens which contained only female genitalia.

Inamdar (1942) described *Shipleya farrani* from *Himantopus himantopus* in India. The scolex of his specimen bears a "papilla" 160 microns long which, judging from his illustration, looks very much like a rostellum. The genital pores are described as alternating irregularly, and the testes are seen anterior to the ovary in a few mature segments. The ovary is bilobed and the uterus ring-shaped. The considerations presented here cast doubt on the relationship of Inamdar's species to *Shipleya*. Not having seen his specimens, we defer decision on the allocation of *Shipleya farrani*.

Burt (1939) stressed the close resemblance between the dioecious cestode *Infula* and the genera *Gyrocoelia* and *Shipleya*. In view of the information presented above, the relationship between *Shipleya* and *Infula* is even more striking. As far as can be determined, the 2 major differences are the presence of a rostellum and a ring-shaped uterus in *Infula*, and the absence of a rostellum in *Shipleya* which

has a horseshoe-shaped uterus. It is questionable whether *Infula* deserves separate generic status on the basis of these differences. Unless further evidence to the contrary is presented, the species of *Infula* should probably be assigned to the genus *Shipleya*.

Shipleya Fuhrmann, 1908

Revised generic diagnosis: Acoleidae with a large scolex. Sexes separate. Testes in several dorso-ventral layers. Cirrus prominent, armed with numerous large hooks. Female genitalia median. Yolk gland postero-dorsal to ovary. A large receptaculum seminis present. Uterus horseshoe-shaped with anterior diverticulum, and developing numerous side branches. Distal end of vagina very similar to cirrus pouch in male. Adults in charadriiform birds.

Type species: *Shipleya inermis* Fuhrmann, 1908.

Shipleya inermis Fuhrmann, 1908

Specific diagnosis: Scolex without rostellum or hooks, diameter range 0.9–1.37 mm; sucker diameter range 250–357 microns. Genital pores alternating regularly. Excretory system consists of 2 pairs of longitudinal ducts, both with cross-connections in each proglottid.

Male: Total length 3 cm, greatest width 2.6 mm. Mature proglottids with about 25 closely approximated testes in at least 2 dorso-ventral layers, nearly in center of proglottid. Cirrus pouch extending to or beyond mid-line of proglottid; cirrus pouch length range 552–900 microns. Cirrus armed with numerous large hooks. A thread-like, short connection between proximal end of cirrus pouch and testes is present. Testes disintegrate in posterior portion of strobila.

Female: Total length up to 8 cm; strobila greatest width range 2.3–3.5 mm in relaxed proglottids. Female gonads median. Ovary with many slender lobes. Seminal receptacle and shell gland present. Uterus in early mature proglottids horseshoe-shaped enclosing the female gonads, developing numerous side branches eventually filling proglottid. Vagina not extending to mid-line of proglottid, length range 380–850 microns, with cirrus-like organ as in male armed with hooks up to 30 microns long.. Eggs measure 30–32 × 51–57 microns.

Type host: Gallinago undulata gigantea
Other hosts: *Gallinago delicata, Limnodromus* spp.

SUMMARY

Eleven specimens of *Shipleya inermis* Fuhrmann, 1908, are described from 7 dowitchers in North America. Evidence is presented that this cestode is dioecious. Revised generic and specific diagnoses are included. The relationships of the species of *Shipleya*, and of the genera *Shipleya* and *Infula* are discussed.

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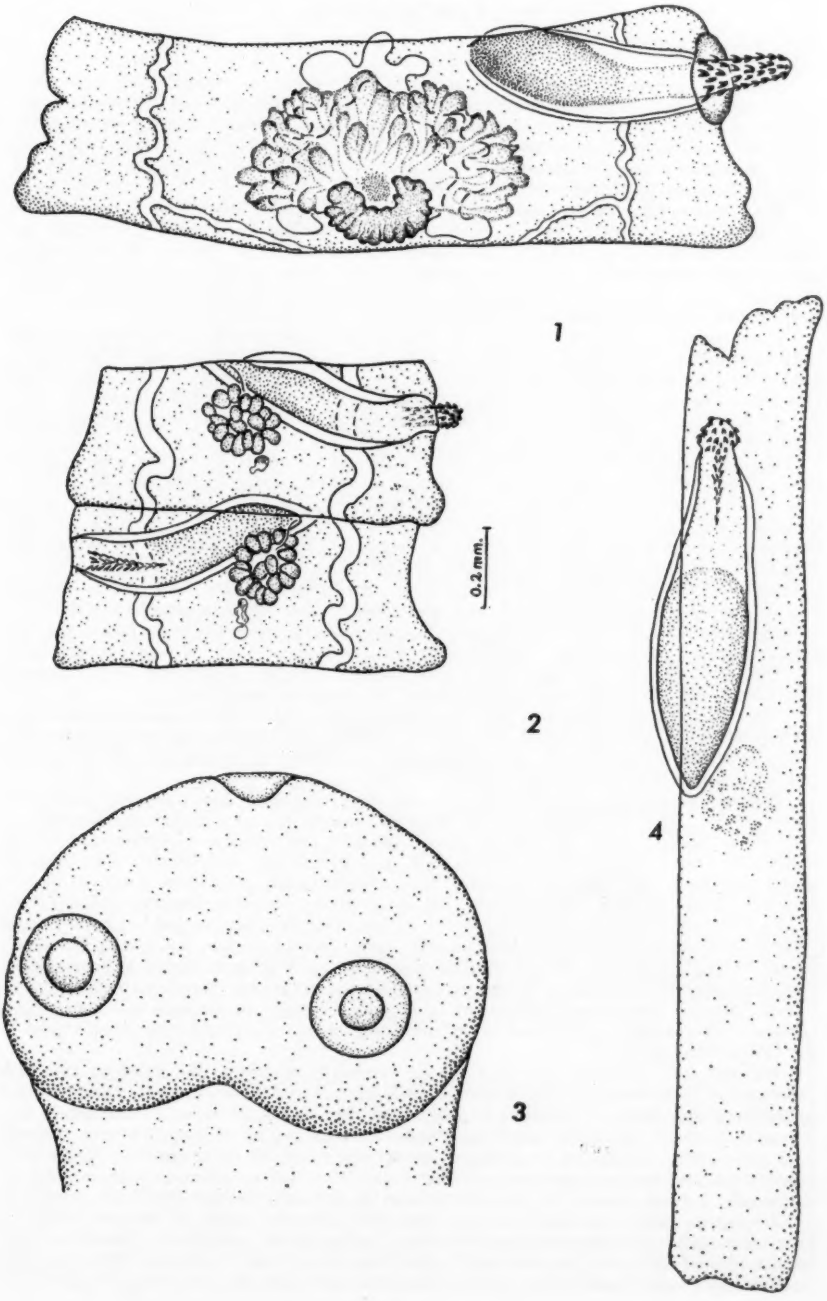
EXPLANATION OF PLATE

(All drawings made with the aid of a camera lucida.)

FIGURE 1. *Shipleya inermis.* Female mature proglottid.
FIGURE 2. *S. inermis.* Male mature proglottid.
FIGURE 3. *S. inermis.* Scolex.
FIGURE 4. *S. inermis.* Old male proglottid. The testes have disintegrated. A few granules only remain.

PLATE I



RESEARCH NOTES

MICROFILARIA IN ELEPHANTS

During the course of one of the writer's (D.E.M.) duties as Animal Pathologist with U. S. International Coorperation Administration Mission to Thailand, a request came on June 1955 for assistance in diagnosis and treatment of an ailment of some of the work elephants owned by one of the companies engaged in teak logging operations. The location was north central Thailand near the Burma border and between Sawankaloke and MgTern. A 1½-day hike was necessary to gain entrance to the area.

The company reported that some of the elephants were unable to perform a normal day's work and were in thin flesh. These animals enter the "rest camp" in January and in May are taken to the work area which varies in location from year to year. During the past year it was reported that out of 50 elephants an average of 30% of the animals were on "sick leave". There has been a death loss of 12 during the past 2 years. It is the practice of this firm during each season to work elephants on a schedule of 3 days work and 2 days rest.

Three months previous to this visit the Thailand Livestock Development Department had made an examination of this herd and found liver fluke eggs and nematode eggs in fecal specimens but no parasites in the blood stream. At this time hexachloroethane, 160 gms. divided into 3 doses (given on 3 consecutive days) was administered as a liver fluke treatment. This was administered by coaxing the animal to eat rice and as the mouth was open, handfuls of the powdered drug were thrown into the posterior mouth.

This report concerns 27 adult work animals, male and female, most of which were in a fair state of flesh. There was no evidence of ventral edema or anemia. Numerous skin nodules, 1 to 5 cm in diameter, and usually oozing with moisture, were found on all elephants. From many of these warble larvae (Estridae) about 1 cm in length could be removed by pressure. Caretakers reported that large subcutaneous swellings discharging pus are not uncommon. Drops of blood were collected from an ear vein, placed on a glass slide, and immediately examined under the microscope for blood parasites. Examinations were made during daylight hours. Twenty-one animals (78%) showed microfilariae. Sometimes as many as 6 slides were examined before 1 microfilaria was located. In other cases several could be located in the first slide examined. Because adult parasites were not available classification was not attempted.

Thin blood films on clean glass slides were fixed for 5 minutes in absolute alcohol, stained with Giemsa for 30 minutes and examined under oil immersion objective.

Three parasites studied showed the following structures and average measurements (dimensions in microns): Sheathed, length 160, width 6, cephalic space length equal to width, anterior end to nerve ring 37, anterior end to excretory pore 67, anterior end to anal pore 107, continuous row of somatic cells to tip of a pointed tail.

Filariasis is common among man and animals in Southeast Asia. Ramanujachari and Alivar (1954, Indian Veterinary Journal **31:** 37–40), quote Van den Berghe as observing in the Belgian Congo, (1937, Ann. Parasitol. **15:** 229–230), microfilariae in elephants which he named *Microfilaria loxodontis*. Later, in 1939, Van den Berghe and Gillian (Rev. Zool. et Botan. Africaines **32:** 388–393) described the presumed adult, *Loxodontofilaria loxodontis*, from the African elephant. He also quotes Baylis (1923, Ann. and Mag. Nat. Hist. **11:** 211–217) as observing in the Tanganyika Territory, Africa, elephant parasites which were termed *Filaria goosi*. Presumably no microfilariae were found. Ramanujachari also quotes Evans and Rennie (1910, J. Trop. Vet. Sci. **5:** 240–256) as finding microfilariae in Burma elephants which they designated *F. elephanti*. In his own studies Ramanujachari found microfilariae only within cutaneous hemorrhagic nodules, ½ to ¾ inch diameter, on the neck and abdomen of elephants. No parasites were found in the circulating blood. He places these microfilariae in the "Parafilaria" group.

Personal communication with R. S. Jones, veterinary advisor to the Thailand Livestock Development Department, reveals that since 1945, microfilariae have repeatedly been observed in the circulating blood of Thailand elephants. Mr. D. Motion, of Louis T. Leonowens Co., Bangkok, Thailand, states that one of the "Mahauts" employed by his company once observed on a post-mortem examination huge long worms located within the heart chamber. Motion once removed, on post-mortem examination, a long worm from the subcutaneous abdominal region. Apparently the body location of the adult filariae in elephants has not been well established.

During the study here reported, fecal specimens collected showed 17 animals (63%) to have various degrees of nematode egg infestation. Unlike earlier examinations, liver fluke eggs were not found—DAVID E. MADSEN, *44 So. 4th Street, San Jose, California;* RAMPUNG DISSAMARN and TAVIL CHOMANAN, *Thailand Livestock Development Dept., Bangkok, Thailand.*

A CASE OF BOVINE TRYPANOSOMIASIS DUE TO *TRYPANOSOMA THEILERI* IN ILLINOIS

In September, 1954 a 2½ year old Polled Hereford heifer was brought to the University of Illinois veterinary clinic for treatment. We are indebted to Dr. W. N. Chandler, Minier, Illinois, for his cooperation in this case.

This animal had never been out of Illinois. She had aborted three days before, and had diarrhea and atony of the rumen at the time of admission. She had been stiff and depressed since June. Blood transfusions and treatment with various drugs were ineffective. The animal did not improve, but died as the result of an accident about four weeks after admission.

Trypanosoma theileri was found in blood smears examined about three weeks after admission. A 3½-week old crossbred Holstein-Hereford calf was injected intravenously with 100 ml. of citrated blood from the infected heifer. *T. theileri* was found in its blood one day later. The calf was depressed and had a slight temperature on the fourth and fifth days after exposure, but then returned to normal. Trypanosomes were present in its blood 12 days after exposure, but two months later they were no longer found.

Wet smears of blood from the heifer's dam and sister were examined, but no trypanosomes were seen.

Even though *T. theileri* is presumably common in North American cattle, it is rarely found in blood smears. Crawley (1912, U.S.D.A. Bur. Anim. Indus. Bull. **#145,** pp. 39) found it in blood cultures from 74% of 27 cattle around Washington, D. C., and Glaser (1922, J. Parasit. **8:** 136–144) found it in blood cultures from 25% of 28 New Jersey cattle. Neither found it in direct blood smears. Glaser saw a single crithidial form in centrifuged blood from one cow, and Crawley saw several in two slides made from centrifuged blood, but they were so darkly stained that he could not observe the kinetoplast. Bowhill (1908, Vet. News, Aug. 15, p. 474, copied in J. Trop. Vet. Sci., 1909, **4:** 104–105) found it in the blood of a British Columbia cow. Watson and Hadwen (1912, Parasit. **5:** 21–26) saw a single individual in the blood of another British Columbia cow. Atchley (1951, J. Parasit. **37:** 483–488) found it in the blood of 1% of 500 South Carolina cattle, and it was present in the blood of the cattle in the outbreak of trypanosomiasis in Ontario described by Hall (1953, Rep. Vet. Director Gen., Canad. Dept. Agric. for 1952: 8–54).

T. theileri is ordinarily non-pathogenic, but under conditions of stress it may cause serious symptoms and even death. Carmichael (1926, Trans. Roy. Soc. Trop. Med. and Hyg. **20:** 303–304) and Hornby, Evans and Cornell (1934, Ann. Rep. Dept. Vet. Sci. and Anim. Husb., Tanganyika, 1933: 34–36) found that it caused losses in cattle being immunized against rinderpest in Africa. Wyssmann (1935, Schweiz. Arch. Tierheilk. **77:** 401–415), Schmid (1938, Münch. Tierärztl. Wochenschr. **89:** 25–26), Bourgeois (1941, Schweiz. Arch. Tierheilk. **83:** 467–469) and Stirnimann (1947, Schweiz. Arch. Tierheilk. **89:** 140–141) believed it to be the cause of an anthrax-like disease in cattle in Switzerland and southern Germany. Carmichael (1939, Parasit. **31:** 498–500) found masses of *T. theileri* in the brain of a cow which had died with symptoms of "turning sickness" in Uganda, and Hall (*loc. cit.*) reported an outbreak of trypanosomiasis on an Ontario farm in which 20 out of 45 cattle died. While it cannot be proven, it is possible that in our case some other condition may have lowered the heifer's resistance sufficiently to permit *T. theileri* to multiply and become pathogenic.

The length of *T. theileri* is usually given as 60 to 70 microns, although much smaller forms are known to occur. Wenyon (1926, Protozoology. London. Ballière, Tindall & Co. vol. 1, pp. 778) stated the minimum length to be 25 to 30 microns, while Crawley (*loc. cit.*) reported his forms to be about 14 to 17 microns long, exclusive of the flagellum. The protozoa in our case were about 34 to 40 microns long, exclusive of the flagellum.—NORMAN D. LEVINE, ADOLPH M. WATRACH, SIDNEY KANTOR AND HARRY J. HARDENBROOK, *College of Veterinary Medicine and Agricultural Experiment Station, University of Illinois, Urbana.*

INTESTINAL PARASITES IN A GEORGIA MENTAL HOSPITAL

The literature reveals few studies on the incidence of intestinal parasites in the State of Georgia, either in institutional populations or otherwise. Byrd (1936, Am. J. Trop. Med. **16:** 39–45; 1937, J. Parasit. **23:** 213–215) reported the incidence in individuals on the relief rolls in Athens, Georgia, and in college freshmen at the University of Georgia. Reardon (1941, J. Parasit. **27:** 89–90) studied a small group of white female patients at a Georgia mental hospital for prevalence of *Entamoeba histolytica* and intestinal helminths. Goldman and Johnson (1952, J. Parasit. **38:** 86–87) report the incidence of intestinal parasites in a group of children and adults at an Atlanta children's clinic. Because of the paucity of data available it is thought that the present study may be of value in establishing the incidence of parasites within the State.

A total of 1134 persons were examined as follows: newly admitted white female patients, 922; a group of 92 employees who had worked at the institution for considerable lengths of time (at least one year); and a group consisting of 120 new employees and members of their families (adults and children). No effort was made to separate the employee group in regard to sex, age, race, or type of work they did (attendant, culinary, nursing *et cetera*).

Generally a single stool specimen was examined by a simple saline smear, an iodine-stained smear, and by a zinc sulfate centrifugation-flotation technique. In about 10 per cent of the individuals two or more specimens were examined by these methods. Occasionally, to establish a more certain diagnosis, permanent preparations (iron-hematoxylin) were used. The specimens were always examined on the day of passage.

Table I presents the results of the examination. The rates of infection with all parasites

Table I. Incidence of intestinal parasites in three population groups at the Georgia State Hospital

	White female Admissions (922)		Employees (92)		New employees and families (120)	
	No.	Per cent	No.	Per cent	No.	Per cent
Entamoeba histolytica	17	1.8	3	3.2	0	0
Entamoeba coli	91	9.9	13	14.1	15	12.5
Iodamoeba bütschlii	3	0.3	4	4.3	0	0
Endolimax nana	66	7.2	8	8.7	10	8.3
Dientamoeba fragilis	1	0.1	0	0	0	0
Chilomastix mesnili	22	2.4	5	5.4	6	5.0
Trichomonas hominis	2	0.2	0	0	1	0.8
Giardia lamblia	11	1.2	3	3.2	12	10.0
Ascaris lumbricoides	0	0	1	1.1	0	0
Hookworm	22	2.4	7	7.6	12	10.0
Strongyloides stercoralis	4	0.4	1	1.1	0	0
Trichuris trichiura	1	0.1	1	1.1	4	3.3
Total infected	161	17.5	29	31.5	42	35.0

Table II. Incidence of intestinal parasites in three surveys

	Per cent infected				
	Byrd, 1936 (Relief)		Byrd, 1937 (Freshmen)		Burrows, 1943
	124 White females	537 Total	364 White females	729 Total	152 White Female admissions
E. histolytica	7.2	6.1	3.8	5.2	1.3
E. coli	29.0	25.9	25.5	24.5	17.1
I. butschlii	1.6	1.5	1.9	2.6	0
E. nana	22.6	22.0	16.5	20.0	12.5
D. fragilis	0	0	1.9	1.4	0
C. mesnili	2.4	0.7	0.3	0.7	4.6
T. hominis	0	0	0	0.3	4.6
G. lamblia	9.6	5.4	7.9	8.4	2.6
A. lumbricoides	0.8	0.2	0	0.1	0.7
S. stercoralis	0	0.4	0	0.1	0
T. trichiura	0	0	0.5	0.3	0
Hookworm	1.6	0.6	0.3	3.0	3.9
Hymenolepis nana	0	0.6	0	0.3	0

seem to be reasonably low. It is apparent that employees of the institution were in general more heavily infected with parasites than the newly admitted patients. The higher incidences of some parasites (*Giardia*, hookworm, and *Trichuris*) in the group composed of new employees and families of employees may be due to the inclusion in that group of a fairly large percentage of children of employees in whom higher incidences of these parasites might be expected.

In general the incidences of the various parasites were lower in the group of white female admissions than were seen in the groups studied by Byrd (1936, 1937). These surveys may be compared in Tables I and II. Where comparisons were possible, only in *Chilomastix mesnili*

and in hookworm did we find higher rates of infection in the admissions group. In comparing our white female admissions with a similar group studied by Burrows (1943, Am. J. Hyg. **38**: 293–305) in the South Carolina State Hospital (Table II) it is apparent that in most cases our rates were lower. We found slightly higher rates of *Entamoeba histolytica, Iodamoeba bütschlii, Dientamoeba fragilis, Strongyloides stercoralis,* and *Trichuris trichiura.* It should be pointed out that in the surveys cited above somewhat less extensive methods of diagnosis were used than were employed in the present study. Comparison of our findings with those of Goldman and Johnson (1952) is difficult; similar methods were used but the groups were of considerably different composition.

The incidence of most intestinal parasites is subject to a tremendous increase in patients of long residence. This has been demonstrated in the work of Burrows (1943) and Reardon (1941). The latter investigator studied a group of white females at the same Georgia mental hospital and found the incidences of *E. histolytica* to be as high as 44 per cent, *Ascaris* as high as 14 per cent, hookworm 33 per cent, and *Trichuris* 65 per cent. Those found by Burrows at the South Carolina Hospital were somewhat lower but still reflected a large increase.

In the present study the major group was limited to white females and the mental condition which necessitated hospitalization may have influenced the infection rates; however, in spite of these objections the sample may give some indication of the incidence of parasites in Georgia populations.

The author wishes to express his sincere appreciation to the staff of the Milledgeville State Hospital for their cooperation, and to Mr. Andrew J. Harrison, who was responsible for most of the examinations reported.—GEOFFREY M. JEFFERY, *U. S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Laboratory of Tropical Diseases, P. O. Box 717, Columbia, South Carolina.*

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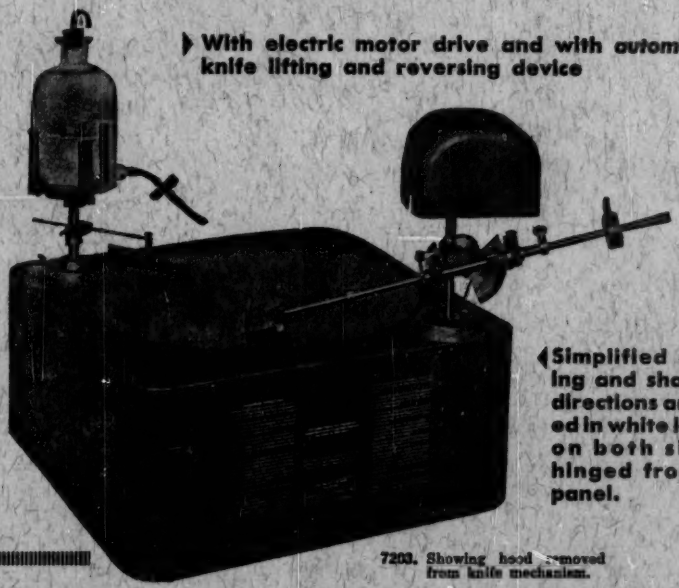

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